CONCRETE COTTAGES

SMALL GARAGES AND FARM BUILDINGS

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(Architects: Messrs. Dunn, Watson and Curtis Green.)

Concrete Cottages at Chepstow.

(See page 147.)

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SMALL GARAGES AND FARM BUILDINGS.

Edited by

ALBERT LAKEMAN, M.S.A., M.C.I.,

Honours Medallist Construction.

Late Lecturer at the Woolwich Polytechnic.

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PREFACE.

COTTAGE construction involves much consideration on account of the limitations of expenditure, which essentially form one of the most important factors in the design and execution of this class of work, and for this reason the subject is an interesting one.

At the same time the question of satisfactory and economical cottage building is one of national interest, owing to the urgent need of healthy and convenient dwellings for all classes of workers who cannot afford to pay anything but the lowest of rentals; and with the constant increase in the price of materials and labour the problem becomes more and more difficult with the progress of time.

The use of concrete for all the main portions of the structure has increased during the last few years and this material can claim many advantages over other materials as regards initial cost, durability and ease of execution which render it worthy of study as a possible solution to the problem.

There are many points to be considered in cottage work and it is necessary to develop a type of building which will combine sound work with economy. This can only be accomplished by a skilful application of cheap and efficient construction to a well-planned simple and convenient design.

The local conditions existing in the vicinity of a cottage site will have some effect on the class of structure, both as regards appearance and accommodation, and the best results will generally be obtained when the designer works on lines which are to some extent based on these local conditions, unless such conditions are of a very low standard.

Concrete is the one material with which full advantage can be taken of local conditions, as local materials and labour can be utilised, and in this respect it is, therefore, the ideal material.

No hard and fast rule can be laid down for cottage work, and attempts to standardise types have not generally proved successful. Some good results might possibly be produced, however, by more standardisation of doors, windows and other features, as such standardisation will allow of economies to be effected without any sacrifice of quality in material.

A great deal of unsatisfactory cottage construction has, unfortunately, been executed in the past, owing to misguided efforts to reduce the cost to a figure inconsistent with reasonable expenditure. One of the objects of this book is to give sound information as to the use of concrete, which will enable those responsible for the conception and execution of this form of construction to produce good work without incurring unnecessary expense.

Various prices are given which illustrate the saving that can be effected over other materials, and, although these are, in every case, those obtaining prior to the outbreak of war, such comparisons will be more than justified at the present

time owing to the increase in price of the majority of building materials being greater than that which has occurred with concrete. There are also other difficulties with regard to many materials which will retard their use, as for example, timber, which is practically unobtainable for this class of work, while the output of the brickyards is very limited, and in some cases has ceased altogether. Thus, the user will do well seriously to consider the question before making a selection, apart from the important question of expense.

Endeavours have been made in this book to deal with both the design of cottages and the practical application of concrete, and many examples of satisfactory cottages which have been executed in this material are given, which will be conclusive evidence as to its adaptability. Many of the designs are of a very high standard and they indicate successful types of cottages apart from any question of material.

The book has been written for the use of builders and building owners, as well as for professional men, and notes are therefore given as to the methods that should be adopted in organising the work, both in the yard and on the site.

The question of labour-saving devices is arousing considerable attention at the present time, and as it was felt that the book would not be complete without some reference to these, notes are given on the chief items to be considered.

Sections are also given on tile-making and fence posts, as these are daily becoming more important items of concrete work, and where the staff and appliances are in existence for block-making, it will be of great benefit as regards cost, if full advantage is taken of these to produce other types of concrete articles.

The use of concrete on the farm is of such importance that a chapter is devoted to this part of the subject, together with a chapter on small garages.

Thanks are due to the authors of the several designs which are published and particularly to Mr. Arnold Mitchell for the drawings and specification of the excellent design which is given on page 140, this being the outcome of many years of practical experience in cottage work.

Special acknowledgment must also be made to " Concrete and Constructional Engineering " and the publishers of " Everyday Uses of Portland Cement " for a large amount of useful information and the loan of many illustrations which occur throughout the book. Various manufacturers of concrete block machines have kindly given particulars of work executed with their appliances and these have greatly assisted in making the volume complete. Two illustrations of American work are reproduced by kind permission from " Concrete," U.S.A.

It is hoped that the book will prove both interesting and instructive to estate owners, members of the architectural profession and contractors, there being no existing treatise on this important subject, and if it affords some assistance in the solution of the problem of cheap and efficient houses for the working classes its objects will be fully achieved.

A. L.

LANGWITH, 1918.

CONCRETE COTTAGES AND SMALL BUILDINGS.

CHAPTER I.

MATERIALS AND METHODS OF CONSTRUCTION.

Section I.

ACCOMMODATION AND PLANNING.

The methods of construction will be affected to some extent by the type of plan adopted, and this point should not be overlooked when efforts are being made to produce economical buildings.

The amount of accommodation to be provided will naturally be governed by the class of occupier for which the cottages are designed ; but there is a minimum limit which should govern all plans, and where a large scheme is proposed, it will usually be found satisfactory to provide two or three types varying from those providing the minimum accommodation to others which are more generously planned. In the smallest type the minimum accommodation will be a fair size living room, a scullery with bath, and three bedrooms, with the usual larder, W.C. and space for fuel ; while in the largest type a sitting room will be given in addition to the living room, and the bedrooms will be of the same number, but slightly larger in size. When space and expenditure permit a separate bath-room is preferable to having the bath in the scullery, as suggested above.

The best type of plan is that which is the most simple and compact, and novel types will invariably be found more expensive than a straightforward arrangement. The chief point to keep in view is the planning of the different apartments in convenient relationship to one another without any waste of space, such as is given with unnecessary passages and staircase landings. The fireplaces should be grouped to allow of the flues being combined into the minimum number of chimney stacks, and the points from which drainage is necessary should be kept adjacent to one another to avoid the formation of drains around the whole or greater part of the building. The bungalow type of cottage will produce a saving in cost under certain circumstances, and the construction is much facilitated in this class of structure, but its adoption is not always possible or advisable, as, for example, when the area of ground is limited or the levels are unsatisfactory.

Detached or semi-detached cottages are usually preferred by the occupants, but these will prove more expensive than those erected in groups of four or six. When larger groups are built, additional expense is incurred by providing separate access to the back of each cottage, and the arrangement is usually not so

convenient ; and this leads to the general rule that, on the grounds of expense, convenience and appearance, the best method to adopt is that of grouping the cottages into sets of four and six where a number are to be built.

These notes are only intended to cover the general principles, and do not claim to cover the whole aspect of cottage planning, as it is a matter upon which a great deal could be written.

MATERIALS.

Concrete in some form or other has been used in cottage construction for many years, and it cannot in any sense be described as a new material. Its extensive application, however, to sections of the building other than foundations, such as for walls and floors has only recently been tried on anything like a large scale, and its merits and possibilities are now being realised. It has several advantages as compared with other materials, and not the least of these is the fact that it will prove to be cheaper than any other type of material which gives permanent construction. Concrete is durable, easily manufactured and very adaptable, and buildings constructed of this material will be fire-resisting, free from vermin and weatherproof, while an artistic design can be reproduced at the minimum cost. There are two things which have retarded the more extensive use of concrete in cottage buildings, and these are :—(1) The restrictions of obsolete bye-laws which were framed many years ago for dealing with other materials, and which do not recognise the possibilities of concrete. These bye-laws need revision in order to bring them up-to-date, when advantage might be taken of the benefits conferred by modern discovery and progress, and there is some indication that the fact is being realised. (2) The prejudice that appears to exist in the minds of many designers and builders against the use of concrete for anything but foundations, to which use it has been applied for so many years. This prejudice will be found in all cases where innovation is suggested in the building industry, and it requires much time and many examples of good work to remove such feeling. The use of concrete for cottage work has, however, made great progress recently, and the need of economical and well constructed buildings of this class has led to a better realisation of its excellent qualities. The concrete used in cottage construction can be divided into three classes, viz.—(1) plain concrete ; (2) concrete block ; and (3) reinforced concrete. The first mentioned will be used in some form or other in practically every building ; the second is the type generally employed for walls ; and the third is adapted for upper floors and roofs, and occasionally for walls.

Plain Concrete.—Good concrete can usually be made with materials the bulk of which is obtainable in the vicinity of the work to be executed, and this fact, combined with the possibility of using unskilled local labour—provided there is proper supervision—enables cottage work to be carried out at a very low rate if full advantage is taken of these possibilities.

A clean, coarse aggregate, of varying size, clean sharp sand and good quality Portland cement, are necessary for making good concrete, and it should be so proportioned as to afford the necessary strength with the greatest economy.

In selecting the coarse material the products of the locality in which the work is situated should be carefully investigated, and the best of these adopted if suitable material cannot be obtained on the actual site itself. It must be remembered that the expense of conveying large quantities of aggregate from a distance to the site will not allow the work to be done cheaply, and it will not be found necessary if proper inquiries are made at the outset. In some districts ballast will be available, and in others stone will be found; and when both are readily obtainable the merits and accessibility of both should be considered. Other classes of aggregate may be used as given below.

NOTES.

Pit Gravel is available in many neighbourhoods, but is frequently mixed with clayey or argillaceous matter, which makes it suitable for garden paths, but not for concrete, unless it is eliminated by washing, a troublesome process. Its suitability can be ascertained by squeezing some in the hand, and if it retains its shape it is owing to its clayey particles, or by stirring some in a pail of water, quite a rough and ready method in common use. If the latter is discoloured to any extent it is unsuitable unless washed again and again.

Brick and Pottery Refuse is a good aggregate if broken to a suitable size, the latter depending upon the purpose it is for, but none larger than would pass a $1\frac{3}{4}$-in. mesh; the smaller the bulk of concrete the finer should be the aggregate. It should not be of uniform size, but graded to that of coarse sand, that the concrete may be homogeneous, or dense throughout. Some experience soon determines this. Breaking with a hand hammer does not give good grading results; nothing is better than a Blake crusher operated by steam power. If the materials are clean, washing is not absolutely necessary, but all materials that have passed through fire or through a crusher are coated with impalpable dust, which it is desirable to eliminate. This is easily performed when mixing the concrete on a movable wooden platform, by sloping the latter slightly to enable the washings to run away, not enough to carry therewith the sand-size portions of the aggregate. The washing should be performed by adding water to the measured heap on the board, while two men—one on each side—turn it over with shovels, while another rakes it about with a long-handled two-pronged rake. If the water is directed to a sump hole, and water has passed away, a thick pasty mass is the result.

Field Flints and Chalk Flints picked from the surface of agricultural land or found embedded in chalk make excellent concrete if crushed, and require no admixture of sand or other ingredients if the crusher is set to the necessary size, but cannot be broken by hand to produce proper grading, and should be washed as previously described.

Brick and Stone Débris from buildings in process of demolition come under the same description as brick-yard débris, except that old mortar should be got rid of as far as practicable. If the concrete is to be used for walls that have to be plastered, chimney bricks should be avoided, the soot hanging thereto penetrates and discolours both lime and cement mortar, and this cannot be remedied.

Stone Quarry Refuse should be passed through a crusher; it is too flaky in character otherwise. Most quarries possess crushers for the purpose. It should be washed as described for brick-yard débris.

River Gravel obtainable from the beds of rivers and their tributaries is usually a good aggregate if clean; but this is not always the case, it is often mixed with mud arising from the soil which is washed in from the banks on either side, but which depends largely on whether it is a quick-running stream or the reverse. The mud is easily removed by washing on the mixing platform, as described previously. Clay is sometimes present in the form of small balls, and these should be removed when the washing is done, as they will be easily recognised. If it contains too large a proportion of the sandy element, the latter should be screened out and used for lime or cement mortar. Too much sand—no matter the kind—weakens the concrete.

Ashes or Cinders from boiler furnaces make good concrete, but require grading, and should be free from other substances, such as cotton-waste, soot from boiler tubes, etc. They may contain fine coal particles, but experiments made in the United States proved that these were not injurious if not more than 5 per cent. was in evidence. Some electric lighting and gas works crush and screen the cinders suitable for concrete purposes.

Ashes from locomotives are usually clean and well adapted for concrete purposes, and most railway companies supply them delivered at any of their stations at a nominal charge, but care should be taken that they do not come from a line where lias limestone abounds. Some railway companies allow their drivers to utilise fragments in the boiler furnaces to economise coal, with a view of obtaining the gratuity which is granted them for low consumption. These fragments when mixed with the ashes are converted into lime, and not distinguishable. Being slow slaking, the latter may not occur until after the concrete has been in place for some time, when irreparable rupture takes place. This applies to the L. and S.W. and some portions of the Midland lines, and possibly to others.

Stone.—If stone is to be used it is best when it breaks in a cubical form, as that which breaks in flat layers, such as shale or slate, does not make so dense and compact a concrete as the former. The stone should be crushed to a size dependent on the purpose for which it is intended. For mass concrete stones up to 2½ in. in diameter may be used, but for walls and floors it should be broken to ¾ in. diameter. The finer portions of broken stone need not be sifted from the larger, as these will assist in filling up the voids, and it is preferable to have material with varying size particles. The quantity of dust should, however, be measured, and if an excess of 10 per cent. of the coarse material is present it should be screened out or considered as forming part of the sand, and the quantity of the latter material to be added should be decreased accordingly.

The coarse material should never be dirty, as the dirt tends to prevent the cementing medium from adhering to the surface of the material with the result that the concrete will be weak.

Sand.—The sand in concrete should be considered as including all particles which are under ¼ in. in size, whether in the form of stone dust formed by the crushing of the coarse material, or in the form of added material. The sand should be clean and sharp, and should have varying size grains. A very fine sand is undesirable, as it is liable to contain a large quantity of fine particles of loam or dust, and it will also contain more voids.

Cement.—The cement should be of the best possible kind, and it will not be found economical to use a cheap and inferior article, because so much of the quality of the finished concrete depends upon this factor. The material should be specified as "the best English Portland cement to comply with the British Standard Specification," as this will ensure a satisfactory cement.

A complete treatise dealing with all the materials used in making cement has been published by The Associated Portland Cement Manufacturers (1900), Ltd., entitled "Everyday Uses of Portland Cement," together with much information on the making of concrete, and the reader is referred to this volume for a description of the measuring and mixing of concrete generally.

CONCRETE BLOCKS.

Concrete in the form of blocks specially moulded and hardened before use has been more extensively adopted for cottage work than any other type of this material, and there are several reasons for this. Some of the advantages are as follows :—

(1) They can be made on the site or in the immediate vicinity, and thus

the cost of carting is reduced to a minimum, especially when the coarse material is at hand.

(2) They are cheaper than brick or stone.

(3) They can be made by unskilled labour, under proper supervision.

(4) The cost of laying is less expensive than brickwork, on account of the larger size of the blocks.

(5) A considerable saving in mortar is effected as compared with brickwork, as there are fewer joints.

(6) The construction is durable, strong and fire-resisting.

(7) The air spaces in the walls result in a satisfactory temperature inside the building.

(8) Pipes and wires can be concealed in the air spaces in the walls.

(9) The internal plastering is reduced to a minimum, as a good surface can generally be obtained with one coat of material only instead of two, as necessitated on brick.

The blocks may be made either by the wet process or the dry process, but, generally speaking, the latter is adopted, as with this method the block can be withdrawn from the mould immediately it is made, whereas with the wet process, sufficient time must be given for the block to harden before it can be handled and this calls for a large number of moulds.

Blocks made by the wet process are more impervious, as a rule, when the same materials and proportions are adopted ; but perfectly satisfactory blocks can be made by the dry process, especially where a facing mixture of a richer quality is employed.

In the dry process only a small quantity of water is added, which makes the materials bind together under pressure, and retain their form when the mould is removed. They should have a consistency which will permit of the mixed materials being squeezed together in the hand to any shape, and remain thus when the hand is opened. As much water as possible should be used, provided the materials will not fall and the block fail when it is being removed from the machine, because, if the mixture is too dry, the blocks are liable to be weak and porous.

The main body of the block, as distinct from the facing, should be made of good materials, well mixed, and all the essential points which apply to coarse material, sand and cement, as given for plain concrete, apply with equal force to block work. The coarse aggregate should be of varying size, particles from $\frac{1}{2}$ in. downward, and the water used for mixing should be clean, free from oil, acid, strong alkalies or vegetable matter. The proportions of the ingredients should be 1 cement, 2 sand and 4 of coarse aggregate, or 1 cement, $2\frac{1}{2}$ sand and 4 coarse aggregate.

When the materials are measured and mixed they are filled into the mould in layers, and consolidated by pressing or tamping by hand, and, generally speaking, the latter method is the more satisfactory and the one most commonly adopted.

When a facing mixture is adopted for hollow blocks it should be composed

of 1 part Portland cement and 2 parts good clean sand, and it need only be about ½ in. thick. In some work crushed granite or stone mixed with cement in the proportions of 2 or 2½ to 1 is employed, and in some cases colouring matter is added to produce a desired tint. (See page 42).

The machine used in block making can be classified generally as either "face down" or "side face," and perfectly satisfactory blocks can be made with either. Some notes on the types of machines, the method of using and the points to consider in the selection, are given in Chapter III (Practical Information for Builders).

Curing of Blocks.—When the blocks are made they must be carefully seasoned or cured before being used in the work, and a large amount of work is spoilt through insufficient attention being paid to this point. In the case of natural curing the blocks should be protected from the sun and wind for at least seven days after making, and as very little water is used in the manufacture they must be frequently sprinkled to allow the action of the cement to develop fully. The first sprinkling should be given as soon as possible without washing out the cement, and in no case should the blocks be allowed to get dry during the first week. They should be left on their bottom boards for 48 hours, or until they can be handled without injury, and frost should not be allowed to affect them. After one week the blocks can be placed in an open yard if the weather is at all suitable, and they should remain there and not be used until they are four weeks old. In the case of steam curing, they are placed in a special chamber containing an atmosphere of steam saturated with moisture for a period of at least 48 hours, after which the blocks are removed and stored for another 12 to 14 days. As a general rule, natural curing is to be preferred of the two methods, and that will be the most suitable one for such work as will be undertaken by the builder with a moderate size business.

There are many varieties of concrete blocks, and some of these are illustrated in Fig. 1. The size of the hollow blocks will vary from 32 in. by 9 in. by 9 in. to 18 in. by 9 in. by 9 in., but it is not wise to adopt the largest size, especially in cottage work, as they will be out of proportion to the scale of the building, and, furthermore, they are not economical, as they weigh about 135 to 140 lb. and it requires two men to lift them into position. The best size to use is 18 in. by 9 in. by 9 in., which is equal to 12 bricks.

Surface Finish.—The blocks may be finished with a plain face, or they may have a "rock face" or be "sparrow-pecked." The rock face is particularly adapted for quoins and similar features.

The most general size for solid blocks is 18 in. by 9 in. by 4½ in. thick for external walls and for internal partitions 18 in. by 9 in. by 2½ or 3 in. thick.

In the case of hollow blocks, the cavities should not exceed one-third the bearing surface, and the material around the cavities should be 2¼ in. thick. A less thickness than 2 in. should never be adopted. The bye-laws in some districts stipulate that with concrete blocks in external walls no portion of the concrete shall be less than 4½ in. thick, and when such a requirement has to be met the use of hollow blocks is prohibited and the only way to comply with the bye-laws is to build continuous cavity walls, consisting of two 4½ in. solid walls connected

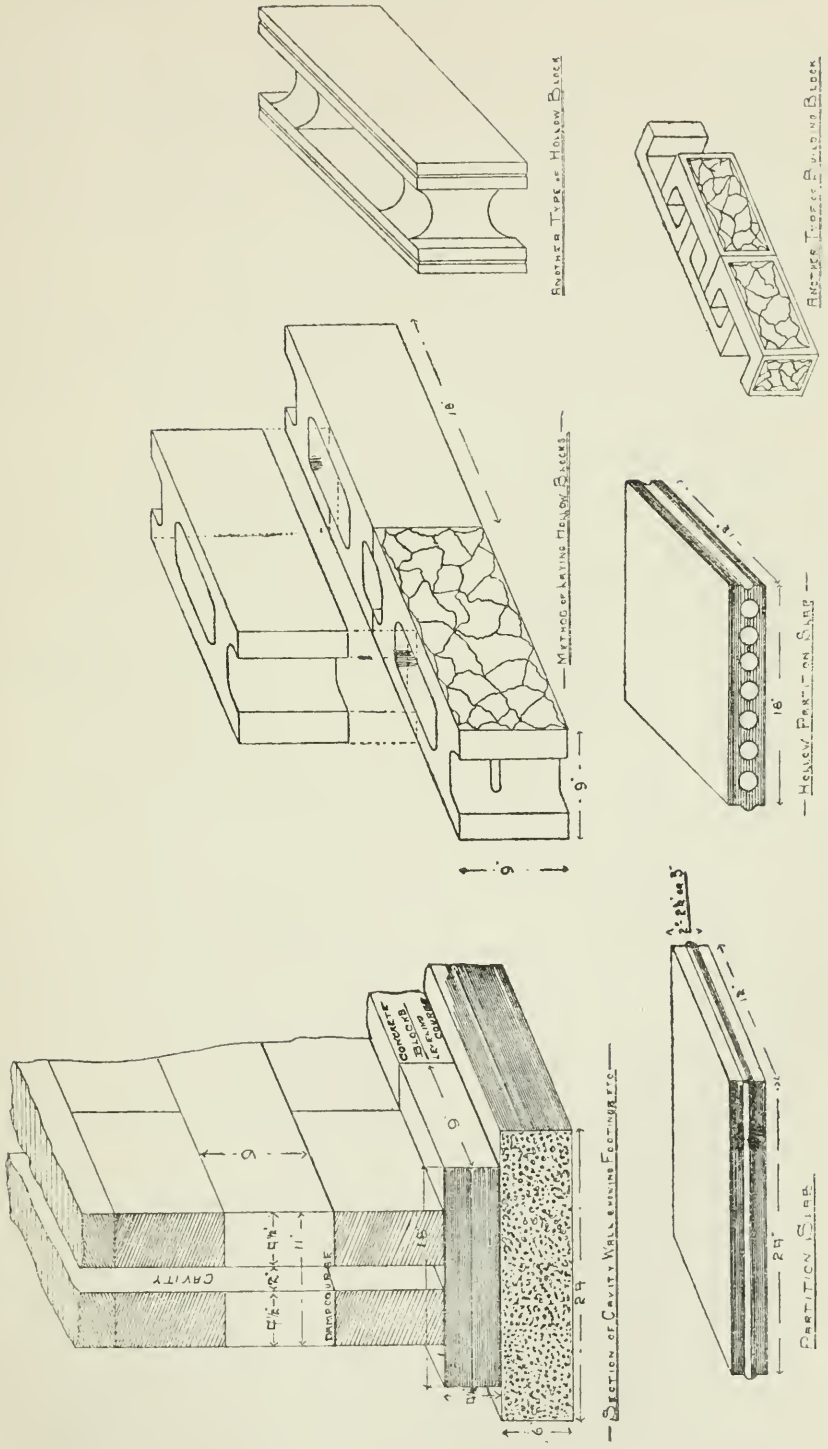


FIG. 1.—SOME TYPES OF CONCRETE BLOCKS.

together with wall ties. It is in such cases that the solid blocks 18 in. by 9 in. by 4½ in. mentioned above are used.

In the Regulations of the London County Council it states that where hollow concrete blocks are used in external walls thay shall conform to the following requirements :—

(*a*) The aggregate thickness, including any cavity, shall be at least 8½ in., measured at right angles to the face of the wall.

(*b*) The sides shall be at least 2 in. thick.

(*c*) The ends and any interior partitions shall be at least 1 in. thick.

(*d*) The clear unsupported span of any part of any side, end or interior partition shall not be more than four times the least thickness of such part.

(*e*) The aggregate thickness of the material shall be at least 6 in. measured at right angles to the face of the wall.

The requirements are quite reasonable and in accordance with good work, and the only point which calls for particular mention is the last item, which states that the aggregate thickness of the material shall be at least 6 in. This means that with the ordinary type of hollow block the material at the front and back must be 3 in. thick in each case, whereas a thickness of 2¼ or 2½ in. is quite sufficient and has been commonly adopted in the past for good work.

Before leaving the subject of concrete blocks it is interesting to note some of the remarks on this method of construction as given in the report of the Departmental Committee on Buildings for Small Holdings. Careful inquiry was made into the value of concrete for structural purposes in connection with small holdings, and it was found that blocks were more commonly used than any other form. The following are extracts from the Report which was published in 1913, since when good progress has been made and the standard of the work has been raised.

> "*Concrete Blocks.*—This method of construction is the one which we have found to be most commonly adopted. It is the simplest, and the existence of various machines for turning out blocks on a large scale makes the system easier of adoption than methods which involve more continuous supervision as the work of construction proceeds. For this reason, perhaps, it is the method which gives the most uneven results. We inspected a considerable number of houses built upon this system, and nearly always found that wet had driven through the walls. In some few instances the blocks were so porous as to make the houses unfit for habitation. We also found that the majority of the houses inspected showed a tendency to develop vertical cracks extending the whole height of the walls, not only through the joints, but across the blocks themselves. These cracks increased the difficulty of securing a dry interior. In fairness, however, to the builders of some of the concrete block houses that we saw, and in defence of the method itself, it must be added that we inspected one example of a number of such houses, which was entirely satisfactory, the houses being pleasing in appearance, well proportioned (a result not always easy to achieve in handling a unit so large as the ordinary concrete block), free from cracks and thoroughly dry inside.
>
> "The actual design of the concrete block has not been thought out so well in this country as in the case of a patent block used in Sweden, which provides for almost continuous air space. Hitherto blocks have usually been moulded with an air space in the centre, the inner and outer portions being connected at the ends. If the concrete is porous damp is likely to strike through these solid portions. For this reason

the method of laying double slabs on edge so as to form a wall with a continuous cavity is being adopted in some places, and this method, if the work is carried out properly, is calculated to ensure a dry wall, even with concrete that is slightly porous.

"Whatever opinion may be held as to the practicability of utilising concrete on any extensive scale in connection with the equipment of small holdings, it cannot be doubted that there are likely to be great developments in concrete construction, and, in spite of all the difficulties that exist at present in securing a reliable result with single buildings of concrete erected under ordinary rural conditions, we have seen enough examples to convince us that efforts should be made to develop the use of this material."

If these extracts are analysed it will be seen that the Committee came to the conclusion that—(1) good, dry houses can be erected with hollow block walls; (2) there are likely to be great developments in concrete construction; and (3) efforts should be made to develop the use of this material. When these conclusions are considered in conjunction with the fact that many of the houses inspected showed cracks and dampness, it would appear that the Committee were satisfied that these defects were caused by bad materials and workmanship, such as will be found in any class of construction, and this fact renders it necessary that the subject of concrete work in cottage building be properly studied by all those interested in the use of the material, and sufficient care be taken in the execution and supervision of the work. Provided the materials are properly selected and dealt with as described in this book and good supervision is exercised, there is no doubt whatever that perfectly satisfactory results can and have been obtained with concrete block construction, and there is no justification for prejudice against this type of work, because some examples can be found where defects are to be seen, as the same condition of affairs will prevail in every class of material used in building work. It will always be found to be economical to produce good work whatever material is employed, as bad work entails expense in making repairs at the expiration of the maintenance period provided for in all properly drawn-up contracts, and, in addition, the reputation of the builder is affected by unsatisfactory workmanship. One of the most common causes of failure in the use of concrete blocks is that of insufficient curing, and too much stress cannot be laid on this point.

REINFORCED CONCRETE.

The materials for reinforced concrete must conform to all the essentials of first-class work, and the notes given in connection with plain concrete will apply to this type of construction also. The steel should comply with the British Standard Specification, and the work be executed in accordance with a proper specification drawn up by a competent architect or engineer.

The use of reinforced concrete generally is not extensively adopted for cottage work, as it is not necessary; and it will not prove economical to provide steel for the sake of reducing the concrete, as the former is an expensive material, and its use is only justified where heavy loads have to be carried or exceptional circumstances are met with. It is, however, very useful, and often employed for lintels, floors, roofs and such portions of the work, and, when judiciously

applied, it will prove an excellent material for those purposes. It should be designed by a thoroughly competent designer and not carried out by any rule-of-thumb method, and it should be kept as simple in character as possible. Some examples of its application to small buildings are given in the notes dealing with the details of construction.

NOTE. *Shell Discard Steel.*—At the present time, when it is exceedingly difficult to obtain steel, it may be of interest and useful to mention that Shell Discard Steel has been used by many engineers engaged on reinforced concrete structures with most satisfactory results.

SECTION II.

METHODS AND DETAILS OF CONSTRUCTION.

All portions of cottage construction are of importance, but the method of forming the walls is the one that will commend itself as being of primary importance, because it forms the weight-bearing part of the building, while at the same time keeping out the weather. The cost of the walls will also constitute the largest factor in determining the cost of the whole structure, and the details of this section of the construction will be taken first.

Walls.

Concrete wall construction can be divided into types under the following heads :—

(1) Hollow and solid blocks.

(2) Concrete, either plain or reinforced, filled in between vertical shuttering built up *in situ*.

(3) Concrete filled into moulds laid horizontally on the ground, each mould producing one side of the building, which is raised into position when sufficiently hardened.

(4) Concrete in a more or less liquid state, poured into wood or iron moulds erected complete to the form of the structure. As an example of this work mention may be made of Mr. Edison's "poured cottages."

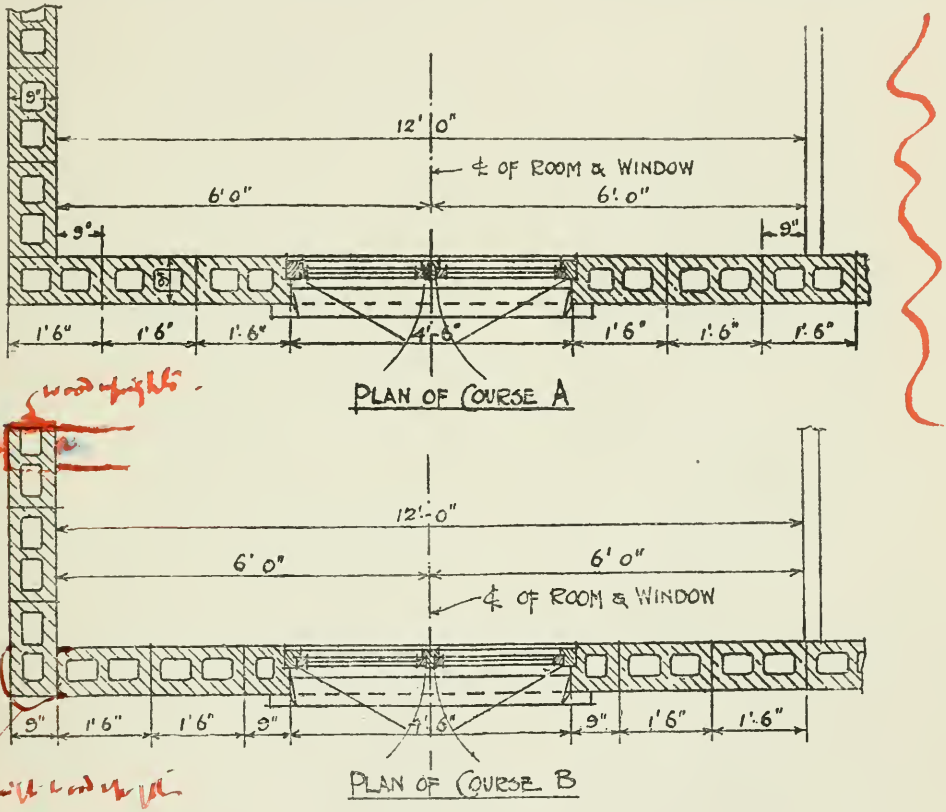
Concrete Block Walls.

When hollow blocks are used they must be 9 in. thick, including the cavity, and they may be built directly on to a plain concrete foundation. This foundation should project at least 6 in. on either side of the blocks, making a total width of 1 ft. 9 in. as a minimum. The thickness should be governed to a certain extent by the nature of the soil, but where this is satisfactory the thickness should be 9 in. A very general practice is to make the foundation concrete 2 ft. wide and 9 in. thick. If the soil is of a clayey nature or likely to be much affected by atmospheric influence, the foundations should be carried down below the level of such influence in order to prevent the wall being endangered by the movement which occurs after change of temperature. This precaution is seldom taken in cheap work, and, in consequence, cracks occur owing to settlement and movement, with the result that much expense is incurred in underpinning

or other repairs. Where the soil is mainly gravel or composed of rock the foundations need only be taken the minimum distance below the surface, viz., 12 to 18 in., and considerable saving will be effected where this is possible, both in digging and walling.

Walls constructed with hollow blocks will not prove so satisfactory as those built with a continuous cavity for the reasons mentioned under solid blocks (*see* page 14.)

An important item in the construction of concrete block walls is that of



FIGS. 2 AND 3.

working to suit the unit length which is being employed, both as regards the total length of the wall and in the placing and size of the openings. The bond will be given by placing the blocks at the corners at right angles to one another, so that the quoin is 18 in. wide in one course and 9 in. in the next, and so on. This will also give the maximum strength, and no special pieces are necessary.

In working along the length of the wall the openings should be arranged to coincide with the ends of the blocks in one set of courses, half blocks being used in the other courses, and the width of the openings should be some multiple of the length of the block employed. The height of the openings should

also be worked in to suit the depth of the courses, as the appearance will not be satisfactory if the blocks have to be cut into odd lengths or the courses are not continuous, and, in addition, unnecessary expense and labour will be caused. These details should always be carefully worked out on the drawings before the work is commenced, and, although it will take some time and trouble in the first instance, the designer will be repaid by the results obtained in the actual structure. After such details have been prepared for one or two cottages, it will be found comparatively easy and quick to draw out subsequent work on the same basis. An example of the spacing of the blocks is given in Figs. 2 and 3, which show alternate courses at the corner of a cottage, and in Fig. 5, where the elevation is indicated.

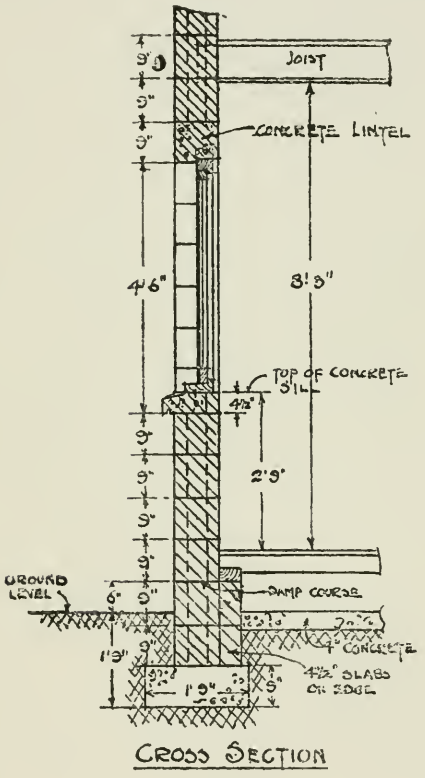


FIG. 4.

In the plan of Course A there are three complete blocks between the window and the corner of the building, and the centre line of the window thus coincides with the centre of the room, which is 12 ft. wide. This necessitates half blocks in Course B to obtain the bond, but no odd lengths are required, and the work is quite straightforward. The width of the window is shown as 4 ft. 6 in., which is equal to the length of three blocks ; but it could be increased, provided that some multiple of a block was maintained. The next width that could be employed would be 4 ft. 6 in. plus 1 ft. 6 in., giving a total of 6 ft., and in this case the half block next to the window would occur in Course A instead of Course B ; while, if the opening is made equal to five blocks in width or 7 ft., the half blocks will remain as shown, and there will be one whole block less in each course between the window and the corner. This example should serve to illustrate the importance of working to some multiple of a block, as it will be realised that with a window, say, 5 ft. 6 in. wide, considerable labour would be involved to make a satisfactory finish and extra expense would be incurred. A section of the wall is given in Fig. 4, and here it will be seen that the courses are worked up from the foundation, and the opening arranged to suit. Concrete lintels and cills should be used with the concrete blocks as shown, and some notes on these will be given later. The arrangements shown in these diagrams are purely for the purpose of explaining the general lay-out of the blocks, and need not be adhered to provided the principle of working to suit the size

of the blocks is realised and the openings and walls arranged accordingly. The wall is placed directly on to the plain concrete foundation as given in the section, and a method of supporting the wall plate under the ground floor joists where a wooden floor of this type is employed is suggested. The damp course is inserted 6 in. above the ground level, and extended through the wall and under the plate above mentioned. In building the wall the blocks should be carried up as uniformly as possible in the different portions of the work, and they should be bedded in cement mortar composed of 2½ or 3 parts of clean, sharp sand, and 1 part of Portland cement. The joints should be about 3/16 in. thick, and well flushed up both on bed and at the ends of the blocks ; but care should be taken

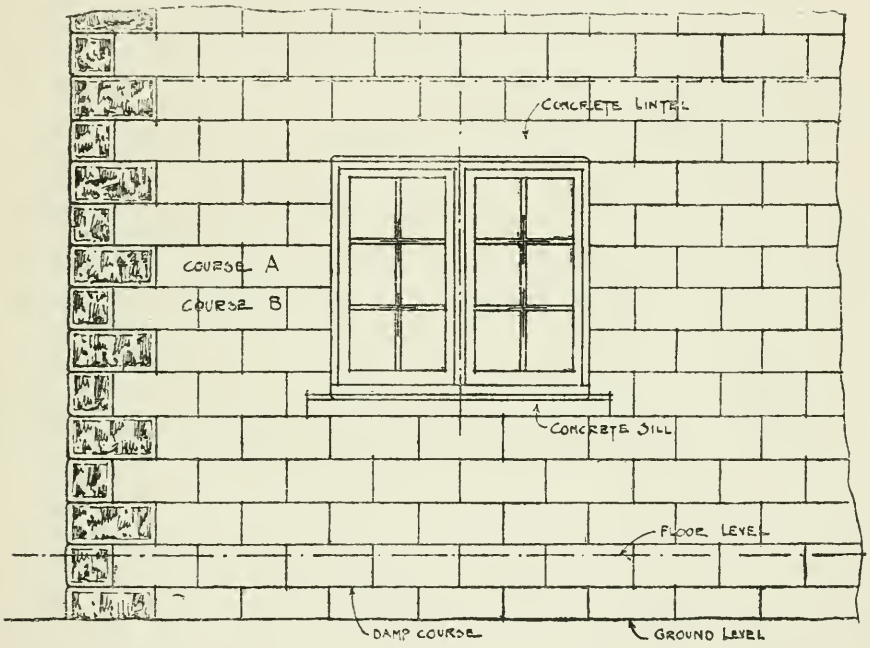


FIG. 5.

to keep the hollow spaces clear of the mortar, to allow as much freedom for air circulation as possible.

If mortar is dropped into the spaces there is also a tendency for dampness to be conducted through the wall, as such material is not at all compact, and it often connects up the outer and inner divisions of the block.

All the external walls should be carried up to the underside of the roof, and arranged in such manner that all the courses are complete. Splayed blocks, having one edge moulded at the same angle as the pitch of the roof are easily made on the block machine, and these should be used for the top course under the eaves and also where gables occur, as this method avoids cutting and ensures the work being executed without a number of small pieces, which are a source of weakness.

All flues and chimney stacks should be built with blocks moulded for the purpose, these being made to take from one to four flues according to the requirements, and different sized blocks are employed to give the necessary bond. An alternate method is to build the chimney breasts and flues up to the level of the roof with concrete bricks, these being about the same size as an ordinary clay brick and made in a similar manner to the blocks. If these bricks are used the work is executed in the same manner as ordinary brickwork, but the blocks must be used for the exposed work of the chimney stack above the roof level if a uniform appearance is to be obtained.

Concrete Bricks.—Concrete bricks can sometimes be used for internal work in conjunction with concrete blocks, to some advantage, and if several cottages are being built it is advisable to have some available on the site. Bricks made with an aggregate of coke breeze are commonly employed in all classes of work for the purpose of providing a fixing, and they are especially useful in concrete block cottages in some situations.

Where walls built of hollow blocks are to be rendered or coated externally with rough cast the appearance as regards bonding and small pieces is not so important, and the work is usually not so thoroughly thought out, but at the same time it is preferable to work out the spacing and build the walls as if there was to be no outside coating, because in this way the work will be of a higher quality as regards strength and weather resistance, and there is no excuse for scamping because the defects will be hidden.

Solid Concrete Blocks.—When solid blocks are used for the external walls they are built with a cavity, usually 2 in. wide, between two $4\frac{1}{2}$ thicknesses of concrete. The blocks being generally 18 in. by 9 in. by $4\frac{1}{2}$ in., they are built on edge to give a course 9 in. high and $4\frac{1}{2}$ in. thick, and the total thickness of the wall becomes 11 in. In building on the plain concrete foundation it is usual to commence by laying one course of blocks on the flat, viz., a course $4\frac{1}{2}$ in. high and 18 in. wide, which is bedded carefully on to the mass concrete to form a level seating for the cavity blocks, which, as above-mentioned, are stood on edge.

Up to the present time experience has proved that this type of construction, viz., two thicknesses of concrete blocks with a cavity between, is the most satisfactory one to employ for domestic work, there being a continuous air space which ensures a dry interior to the dwelling, and the serious trouble which frequently occurs owing to interior condensation is avoided. In the case of hollow blocks it is necessary to make them as non-absorbent as possible in order to render them weather tight, and this has the effect of making the inside surface unable to absorb moisture condensed out of the atmosphere.

A typical section of the foundations of cavity wall is given in Fig. 1, where the method of laying the first course will be seen. The damp course should be inserted, above the ground level, and it should extend through the two thicknesses in separate layers and *not* be carried across the cavity, as is sometimes done, otherwise any moisture which finds its way into the cavity will run down on to the damp course and the cavity will become a form of gutter. This moisture will in time soak through the inner thickness of concrete and the

whole object of the cavity will be defeated. By executing the work as shown on the section any water in the cavity will drop to a point below the damp course, and if the moisture passes through the inner wall below the level of the latter no damage will be done, as it will be unable to rise up into the work above the floor. The inner and outer divisions of the wall are tied together with wall ties, one, at least, of these being provided for every square yard of walling. The ties should be galvanised or tarred and sanded, and they should have a dip or twist in the centre of their length which will prevent water running across them from the outer to the inner division. In placing them in the work they should be staggered, *i.e.*, a tie should be placed in the centre of the space between the ties immediately above and below, and care should be taken that mortar is not allowed to drop on to the ties and remain there, as this will prevent the twist or dip being effective in throwing off the water.

All window and door frames which occur in cavity walls, where the head is exposed to the possibility of water dropping down the cavity, should be covered by a layer of impervious material, which is built into the two thicknesses across the cavity to form a kind of gutter with the ends carried beyond the width of the frame to throw all water clear. In good class work 4 lbs. lead is often adopted for this, but in cheap cottage work zinc can be used, or one of the many good waterproof coverings which are on the market. It must be understood that the outer thickness of walling, which is only $4\frac{1}{2}$ in. thick, cannot be entirely weatherproof, and the object of the cavity is to form a break between the outer and inner surfaces which will prevent the actual passage of moisture, and any woodwork in the cavity which is not protected will be liable to become damp and also conduct damp to the inside of the house. The cavity should be well ventilated at the top and bottom to ensure a free circulation of air, as this will assist in keeping it as dry as possible. The remarks as to the necessity of spacing the openings to suit the size of the blocks, and similar notes given in connection with the use of hollow blocks, apply with equal force in the case of cavity blocks.

Internal Walls, Partitions.—The building of the internal walls and partitions will be a simple matter and follow the lines adopted in all cottage work, with the exception that concrete slabs will be wholly used instead of being only partly used as is often the case in brick structures.

The internal partitions can be divided roughly into three types, viz. (1) those separating one cottage from the adjacent one ; (2) partitions carrying weight ; and (3) partitions not carrying weight. The first mentioned will obviously constitute a party wall, and it must be constructed of the same thickness as the external walls, with the exception that no cavity need be employed as there is no question of keeping out the weather, and it is preferable to use hollow blocks 9 in. thick instead of using cavity blocks even if the latter are employed in other parts of the structure. A proper foundation must be provided and the work constructed in a thorough manner with blocks which have not been moulded with a specially hard or smooth face, except in sculleries and such places where no plaster is going to be applied as a finishing coat.

Partitions which are carrying weight should be constructed with sound blocks suitable for the purpose, and in many cases on the ground floor where loads from the first floor will have to be taken, it is advisable to use solid blocks 4½ in. thick, similar to those employed in cavity walls, as this will give a very strong partition. In many instances it will be quite sufficient to use slabs 3 in. in thickness, and where they are of minor importance 2½ in. slabs will suffice.

For partitions which do not carry any weight the slabs can be 18 in. by 9 in. by 2 or 2½ in., and in the case of those on the upper floor it is advisable to use coke breeze concrete, because this will make the construction as light as possible and prove a cheap and effective method.

The construction will always be more satisfactory if the partitions on the upper floor can be planned to come immediately over those below, but when this is not possible effective means of support must be provided at the first floor level to prevent any tendency on the part of the partition to sag downwards, as in that case cracks will occur. Where the first floor is of concrete the support is a simple matter, but where a wooden floor is adopted bridging pieces between the joists will be necessary. It must be remembered that where wooden framed partitions are used they can be made wholly or partly self-supporting, except for the bearings at the ends, but a concrete slab partition must have support throughout its length, and such support should be sufficiently stiff to prevent deflection when movement is taking place on the floor adjoining the partition.

The slabs used for all partition work should be moulded with a groove or joggle on the outer edges to form a good key between adjacent slabs, and they should be jointed with cement mortar. Where door openings occur in ordinary partitions the frames should be built in as the work proceeds, and a small fillet should be attached to the frame to fit into the groove of the slabs on either side to provide lateral support and generally stiffen the work. At the top of the opening the slabs are merely built on to the head of the frame, and thus no lintel or arch is required.

Some examples of cottages erected with concrete blocks are given in Figs. 6 to 31, as showing the actual practical application of this method of construction, and the successful results obtained should be sufficient evidence as to the suitability of the material for this class of work.

The first examples, Figs. 6, 7, 8, show some concrete cottages erected by the Wayford Tenants, Ltd., on their estate at Wayford, in the parish of Stalham, N.E. Norfolk. In comparison with the existing cottages in the district, which are of the usual type of poorly-lighted, badly ventilated, unsanitary farm labourer's cottages, the new concrete dwellings show to a remarkable advantage from the point of view of efficiency and economy.

The cottages shown are built practically entirely of concrete. The walls are of concrete blocks 18 in. by 9 in. by 4½ in. All external walls are 10 in. in thickness. This allows for a 1-in. cavity between the two 4½-in. blocks.

The partition walls are all built of blocks 4½ in. thick. The floors are kept well above the ground level. The height between floor and ceiling is 7 ft. 10 in.

throughout, and there is at least one large casement window in each room, so arranged that it is possible to have a part open without inconvenience during the severest weather.

A special feature of the cottages is the roofing tiles, which are absolutely weatherproof. They are made of concrete, as are also the flooring tiles or quarries. Both of these being glazed, give the buildings a neat finish. These tiles work out considerably cheaper than the ordinary flat or pin (clay) tile.

One of the cottages shown in the illustrations is of bungalow type, the rooms are commodious, and the roof is so arranged that two bedrooms could be made in it with little expense if required ; but under the present arrangements it will be utilised for a storage loft.

The sizes of the rooms are as follows :—Living room, 16 ft. by 11 ft. ; kitchen, 11 ft. by 9 ft. ; larder, 5 ft. by 4 ft. ; three bedrooms, 14 ft. 6 in. by 10 ft., 11 ft. by 9 ft., and 11 ft. by 8 ft. respectively ; with a coal store, 6 ft. by 5 ft.

Each room is well lighted and ventilated. The ceilings are of " Beavor Board," which is composed of pure wood-pulp, and which gives the appearance of a panel ceiling when finished.

At the back of each house there is an underground tank for the storage of rain-water. This is built of concrete blocks made specially for this purpose. The cover is of reinforced concrete, with a manhole in the centre. A small pump is connected from this for the use of rain-water in the house. The size of the tank is 6 ft. diameter by 6 ft. deep. Thickness of blocks, 4 in.

Special consideration has been given to an efficient drinking-water supply for the cottages, of which there will eventually be fourteen or more. The supply main is 2 in. diameter, and is fed from a concrete reservoir situated on the highest point of the property. This is fed from a well some 200 yards distant from the reservoir. This well is 6 ft. in diameter and is also formed of concrete blocks. The reservoir is 20 ft. square by 5 ft. deep, the walls being 9 in. in thickness. Forty tons of concrete were used in its construction, and the work was completed in one day. The capacity of the reservoir is 10,000 gallons, and the natural elevation gives sufficient fall to obtain the required pressure to supply the fourteen cottages to be erected on the estate.

The cost of the bungalow cottage illustrated here was £185 complete. By the use of blocks a saving of 75 per cent. in the jointing material is effected. Less plaster is also required for the walls, as the surface is less rough than in the case of bricks.

It must be mentioned that all blocks, roofing tiles and quarries were made on the estate.

The second type of cottage shown has the following accommodation, namely : Three rooms on the ground floor, with a scullery and larder, and three rooms on the top floor.

The living room is 16 ft. by 10 ft. 8 in., whilst the scullery is 8 ft. by 10 ft. 8 in., the larder 6 ft. by 4 ft. 3 in. The dimensions of the remaining two rooms on the ground floor are 14 ft. 6 in. by 9 ft. and 11 ft. by 8 ft. The three

bedrooms on the top floor are each 12 ft. by 10 ft. The total cost of this cottage, including painting and distempering, was £200.

The cost of laying blocks (the size of which is as indicated above, and therefore each block equals six bricks) was £3 6s. per 1,000, whilst the cost of laying bricks is 15s. per 1,000 at least. Therefore, to cover an area of 1,000 blocks, 6,000 bricks are needed, the laying of which would cost £4 10s.

This work was executed under the supervision of Mr. B. F. Hartley, the works manager, who was responsible for the design of the reservoir and the moulds for the concrete blocks, &c.

The illustrations, Figs. 9 and 24, show some cottages which have been erected in connection with a further extension of the Kilkenny woodworkers, woollen mills and tobacco plantation industries, which are being fostered under the patronage of the Right Hon. Ellen Countess Dowager of Desart, for whom they have been designed and erected by Mr. F. W. Kiddie, architect, of Talbot's Inch. The plans show a most economical arrangement of rooms, no space being lost, the provision of a large living room and good sized scullery, containing a bath, being particularly suitable for the cottager. It will be noted that three bedrooms are provided. The grouping of the fireplaces is a most economical arrangement, as one set of breasts and stacks serves two houses.

The outside appearance is most artistic and pleasing, the contrast afforded by the " rock "-faced blocks on the ground floor and rough cast on the first floor, and again by the red fibrocement tiles, being extremely satisfactory.

The large gabled windows, which really serve two cottages, are a feature which quite takes the houses out of the commonplace of cottage elevations.

The white-paled fence gives a clean and neat finish to the whole, while the block gate piers add to the substantial appearance.

The whole scheme is a marked indication as to the way Portland cement is entering into modern life. The outer walls are built with " Winget " cement blocks, the partition walls with " Winget " cement slabs, the floors of concrete and the roof with fibrocement sheeting and fibrocement tiles.

An interesting example is that where Messrs. Cubitt, of Gray's Inn Road, were requested to ascertain, from actual experiment, at what cost a pair of working men's cottages could be built, all the resources of a large firm being concentrated upon its solution.

The result of their work is most instructive, and undoubtedly a real step forward has been made.

Cottage building has mostly been in the hands of the small builder, and for obvious reasons. The single cottage, or the pair of cottages, present so small a total of expenditure, that the ordinary percentage of builders' profit is a quite inadequate return to the large firm, unless by means of standardisation, the employment of new methods and the use of cheaper materials, first cost can be brought down. It is in the reduction of first cost that the work here described is so remarkably successful.

The elementary conditions of the problem dealt with by Messrs. Cubitt were :

FIGS. 6 AND 7.—COTTAGES AT WAYFORD, NORFOLK.

To face p. 19.

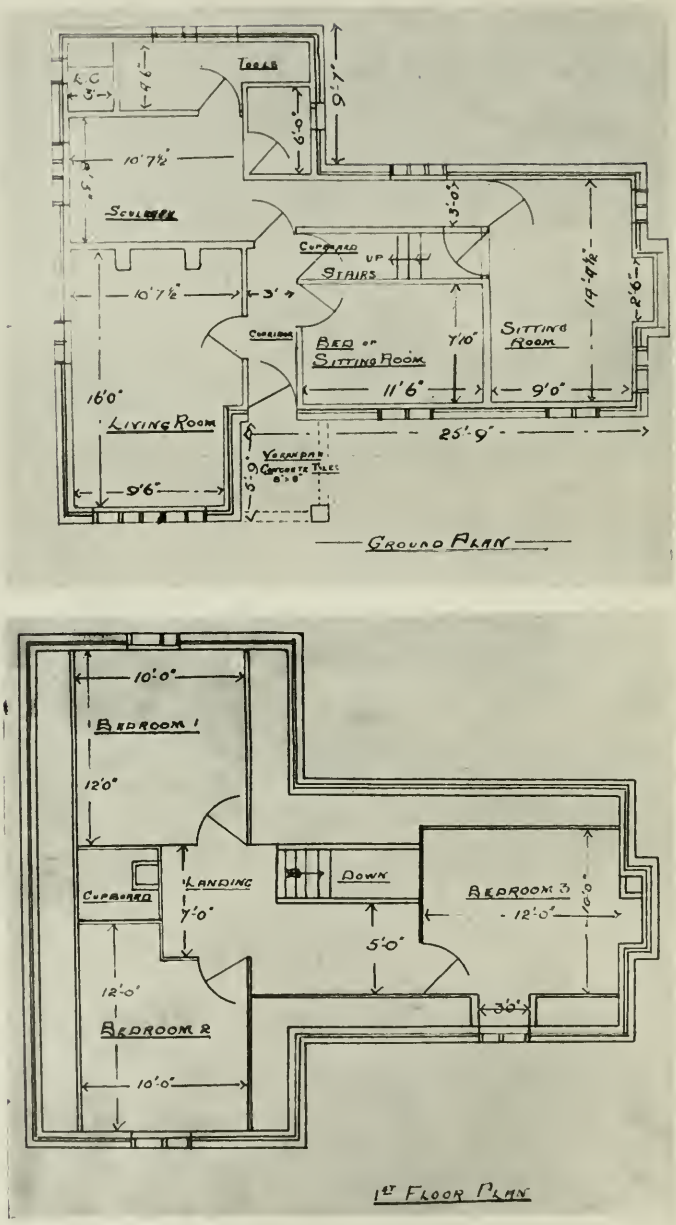


FIG. 8.—PLANS OF COTTAGES AT WAYFORD.

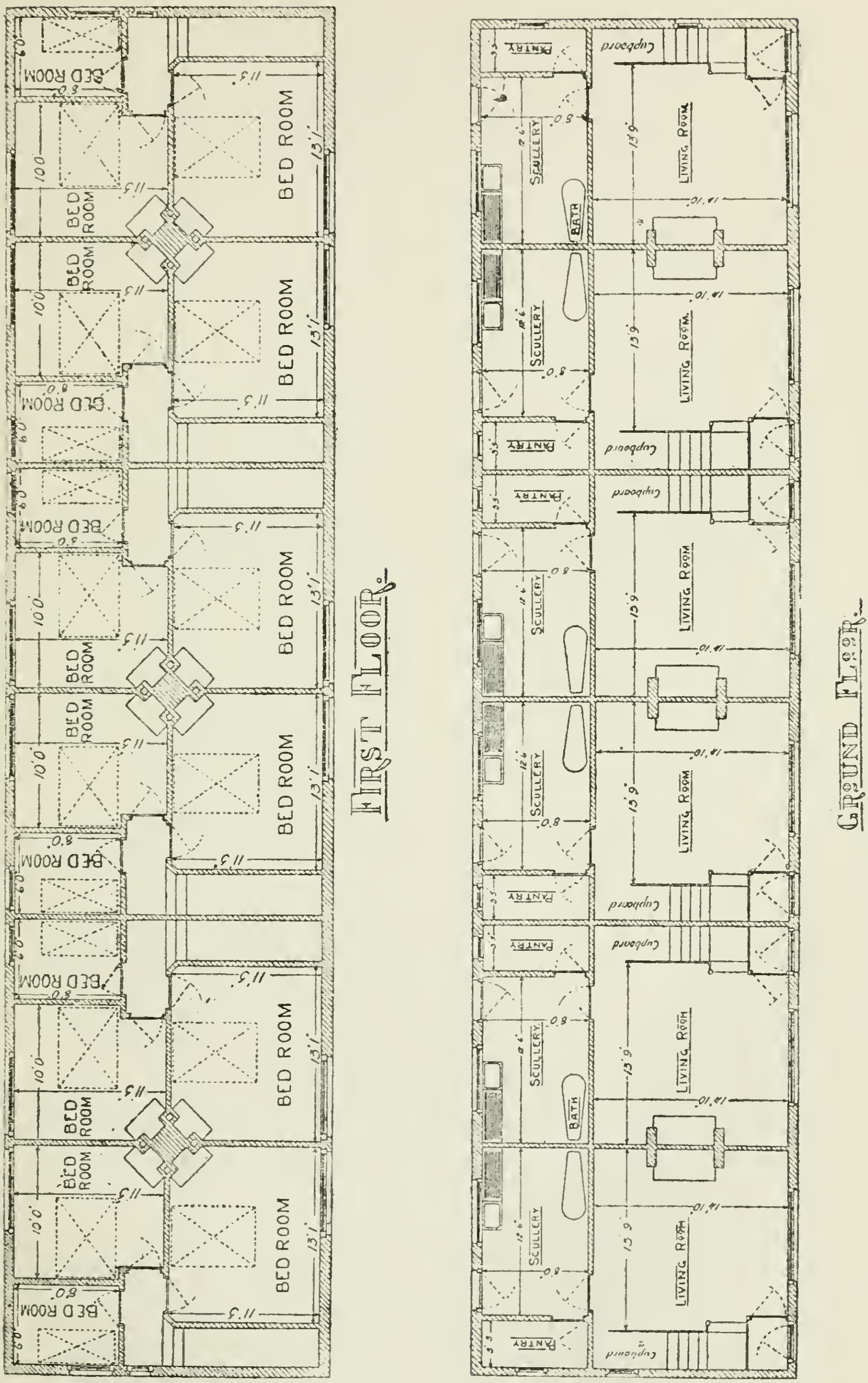
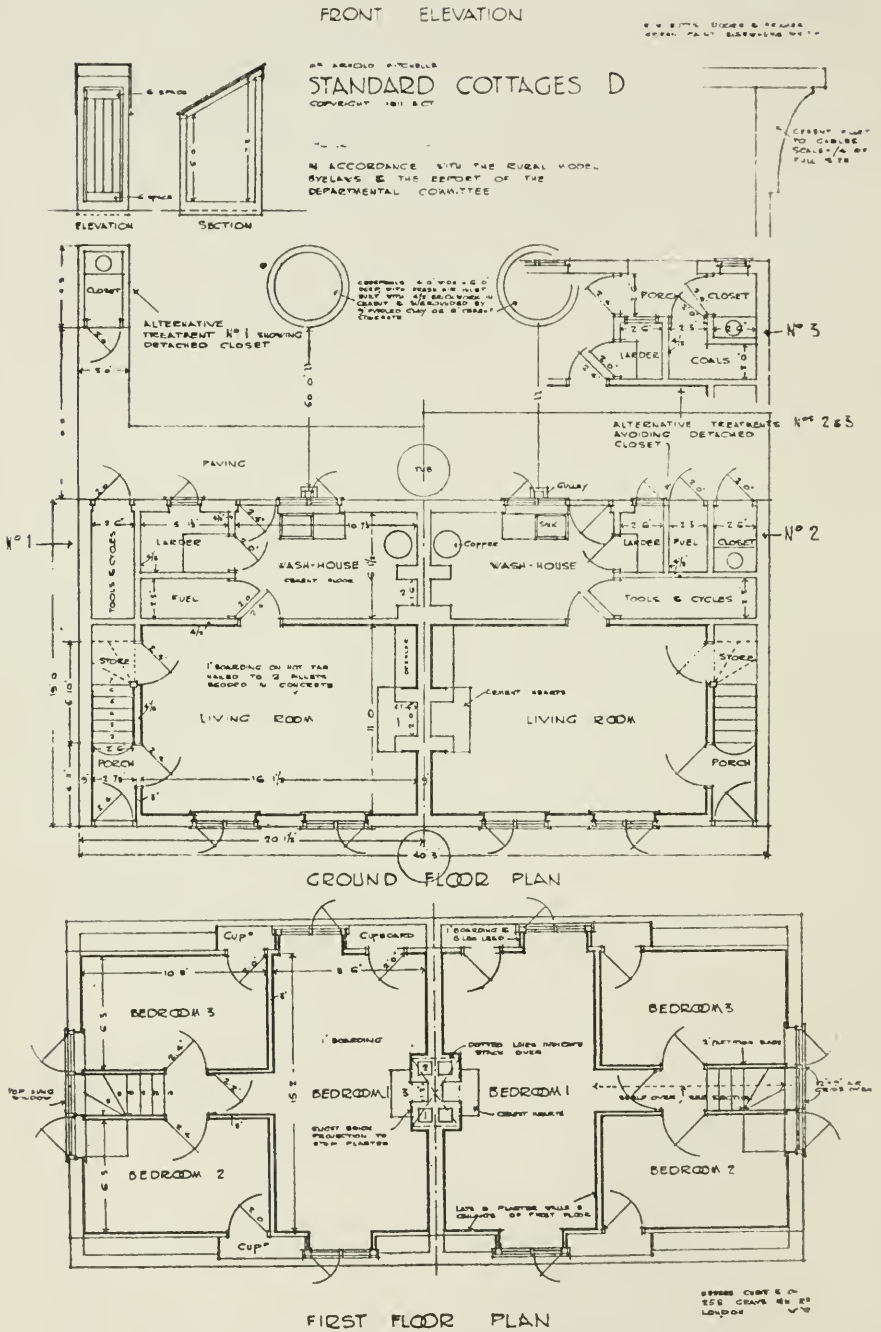


Fig. 9.—Concrete Block Cottages at Talbot's Inch, Kilkenny.



FIGS. 10 AND 11.—PLANS OF MESSRS. CUBITT'S COTTAGES.

(1) The cottage must have adequate accommodation.

The standard of accommodation in a labourer's cottage is not a fixed thing, but for the purposes of this experiment the schedule provided in the Departmental Committee's report—the Committee of which Mr. Christopher Turnor was chairman—was adopted as one generally acceptable.

(2) The cottage must conform to the medical officer's view of what is right and necessary for a healthy habitation.

(3) The cottage must comply with the regulations of the Local Authority. For the purposes of this experiment the London Building Act of the London County Council, and the model building by-laws of the Local Government Board for rural districts, are together the standard adopted.

The whole matter was placed in the hands of Mr. Arnold Mitchell, whose experience in cottage work, loyal co-operation and initiative, ensured success, if success was possible.

To the conditions imposed upon him Mr. Mitchell added a fourth, viz., that—as in all new cottages he is concerned with—all three bedrooms must be upon an upper floor. It is often economical to put one of the bedrooms upon the ground level. Where, however, this is done the room is seldom, if ever, used as a bedroom. Mr. Christopher Turnor is emphatic upon the need for this proper distribution of the rooms.

Each of the cottages built comprises an excellent living room, 165 sq. ft. in area, with good cooking range, a dresser, and with boarded floor ; a 65-ft. sq. washhouse, with hob stove, copper and sink ; a good larder, fuel store and detached closet—these all upon the ground floor. An entrance lobby is provided, and a good well-lit staircase leading up to three bedrooms upon the upper floor. The largest bedroom has an area of 144 sq. ft., and has a good fireplace, and the smaller ones each with 65 ft. sq. A paved area in the rear of the cottage is included, covering 100 sq. ft. in area, and, in addition, there is a good shed, available as wood store, tool house or bicycle shed.

This pair of cottages has been actually built for £250 the pair.

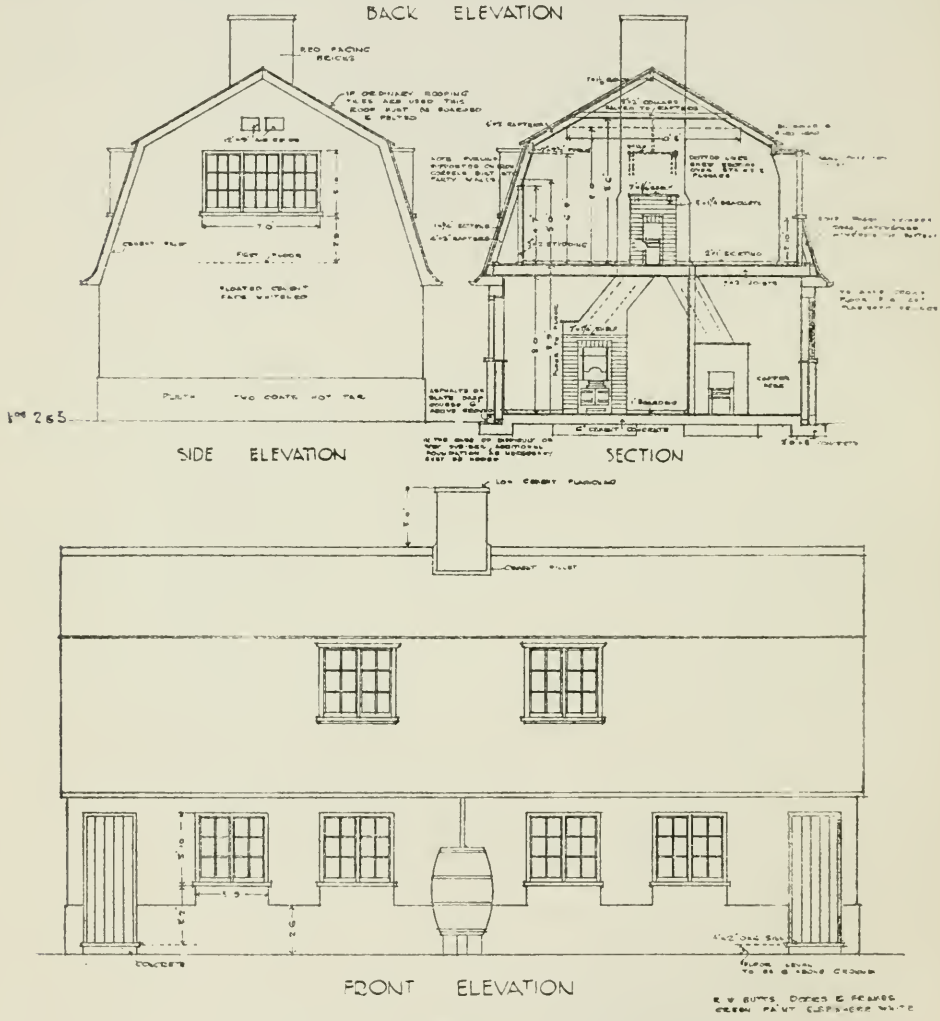
Where a larger number is erected in one place, and at one time, the cost might work out slightly lower, but any considerable reduction is hardly possible. To this amount must be added what is necessary for the builder's establishment charges and his profit.

The whole of the walling is carried out in Portland cement concrete, and the whole of the roof covering is carried out in Portland cement tiling. The structure throughout, excepting only the timber work to roof and upper floor, is made with Portland cement ; and it is this thorough substitution of Portland cement for the more usual building materials which has gone a long way to achieve the result.

In adopting this material, its limitations were also recognised. It was borne in mind that the very excellence of its qualities had often been the source of its undoing where used in cottage building. An ordinary cement concrete wall is so close and homogeneous in its structure, so impervious in its nature, as to present a condensing wall surface quite unfitted for habitable rooms. Cottage

walling, to be good walling, must be of less unyielding material; a material which absorbs the moisture in the atmosphere, instead of condensing it upon its surface.

To this end hollow concrete blocks were employed, and these hollow blocks were made of ash, or cinder, in place of the hard material commonly used.



FIGS. 12 AND 13.—MESSRS. CUBITT'S COTTAGES.

Provided combustion had been perfect and no sulphur remained in the ash, the refuse from the dust-destructor made an ideal aggregate for this purpose; the blocks would be light, and they would be porous; the material was exceedingly cheap; and so the strange sight was seen of refuse being delivered on to the site, and an American concrete-block-making machine at work turning out the most excellent building material.

On another portion of the site a tile-making machine was turning out eighteen large red roofing tiles per hour made of cement and sand. Ashes are no good for tile manufacture. It is just as important to have the roof covering non-absorbent and damp-proof as it is to have the internal walling porous and absorbent. The hollow concrete blocks are rendered externally with cement and sand, and they make a good key for the plastering inside. Where no plastering is required the walling blocks are finished in the machine with a smooth face, and built up ready in the wall for whitening without further labour. All this makes for cheapness, whilst for strength and durability there is no doubt whatever the advantage is upon the side of the cement over other material.

The same economical care exercised in the structure was extended to other

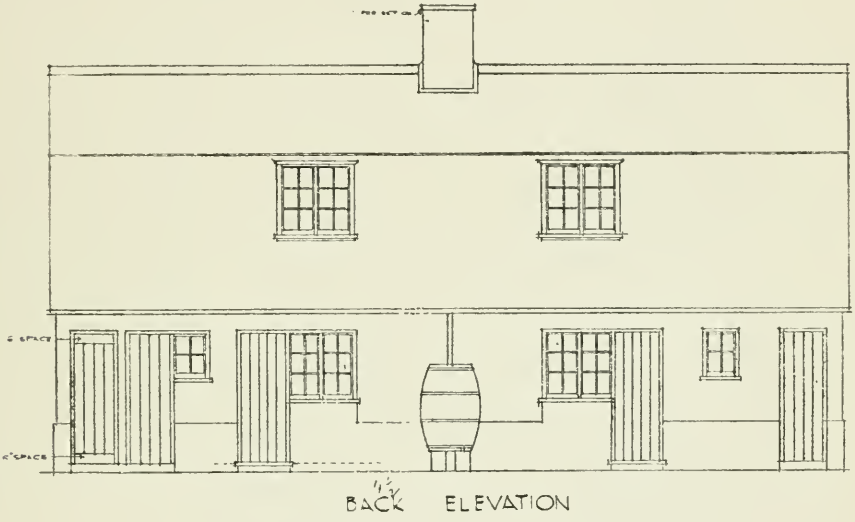


FIG. 14.—MESSRS. CUBITT'S COTTAGES.

portions of the building. The cheapest scantlings of timber were employed; a reduction of something like 50 per cent. was secured on the joinery cost—this by putting the contract out to joinery mills who specialise upon this class of work. Special prices, upon the assurance of large orders, were secured for the ranges, for the grates, and for the ironmongery—prices which will be available to all who apply for them.

The plans are sufficiently detailed to speak for themselves.

The above work was carried out by Messrs. Cubitt, at the request of the Associated Portland Cement Manufacturers (1900), Ltd.

Some very good examples of cottages constructed with concrete blocks are provided in the scheme carried out for the Crayford Cottage Society in Kent, under the direction of the Rural Housing Organisation Society.

The estate is a fairly large one, and the scheme includes 457 cottages and five sites for public buildings, while portions of the land are given up to a recreation ground, village green, bowling green and various allotments, the last-mentioned

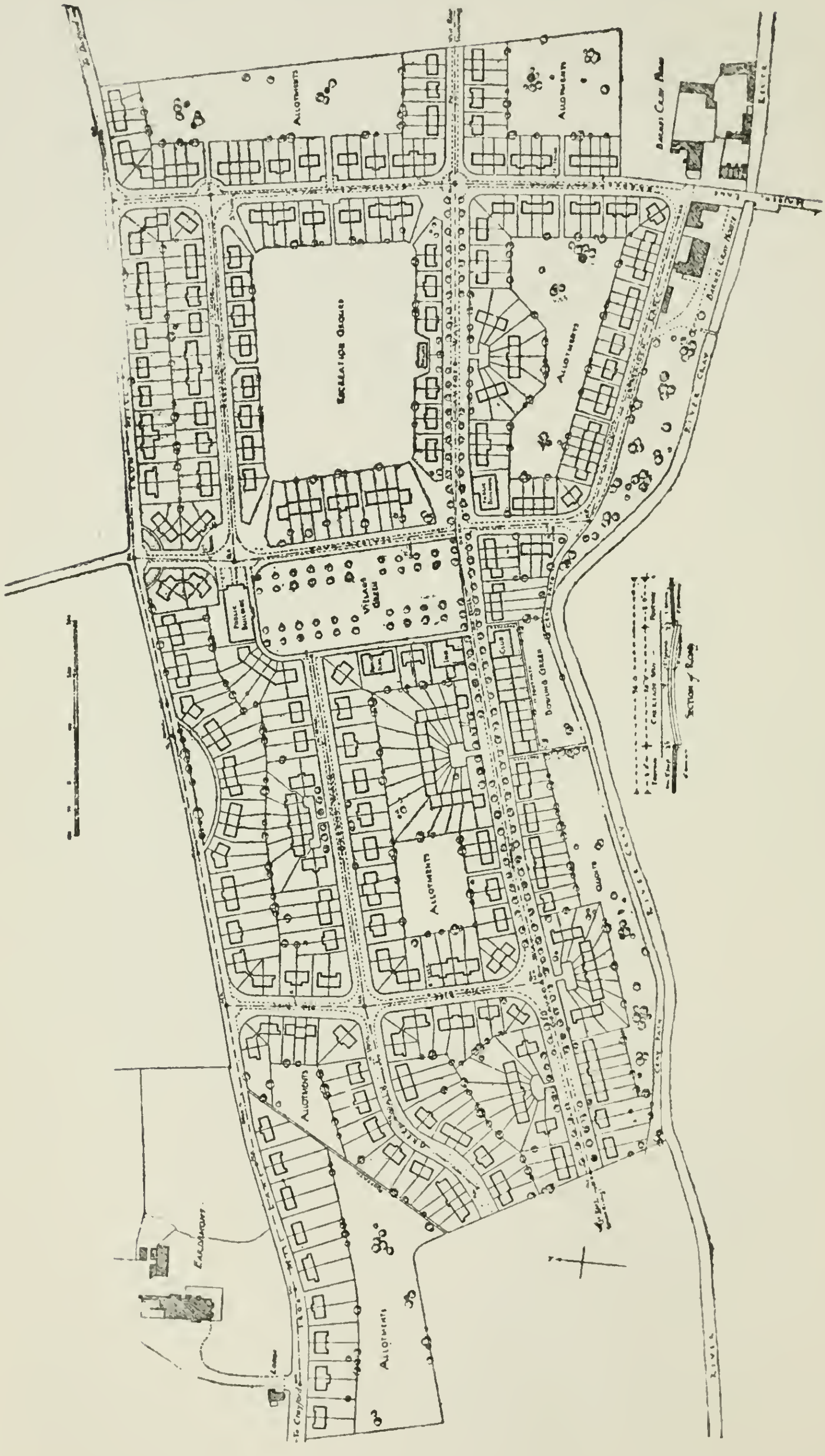


Fig. 15.—Plan showing Layout of Cottages at Crayford, Kent.

being in addition to the large gardens that are to be provided to each cottage, as shown in Fig. 15.

The site adjoins the River Cray, and is quite close to the village of Crayford and but a few minutes' walk from the extensive works of Messrs. Vickers. The concrete cottages were executed by the Cottage Construction Co., of 16-17, Devonshire Square, E.C., and they form the best types of this class of work in the

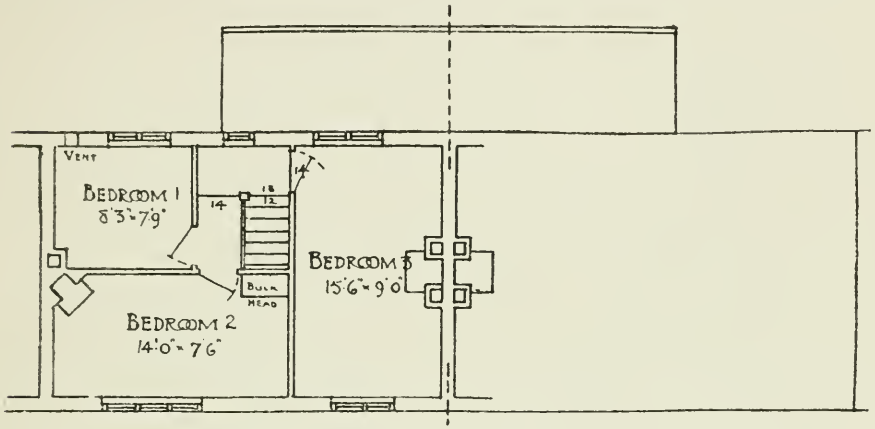


FIG. 16.—FIRST FLOOR.

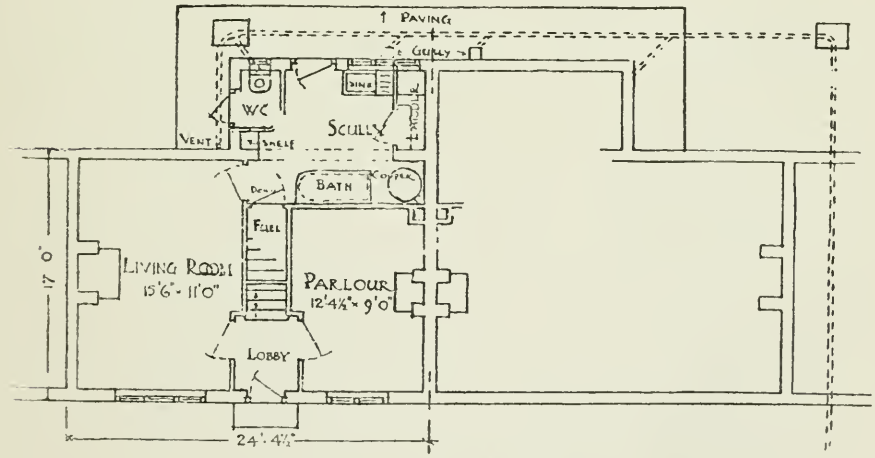


FIG. 17.—GROUND FLOOR.

COTTAGES AT CRAYFORD, KENT.

vicinity of London, and an interesting comparison is afforded between concrete blocks and brickwork, as regards economy and speed of erection in cottage work, which tends to show the former to advantage.

The same type of plan has been adopted for the whole of the cottages now under construction and completed, but the elevations are varied to avoid monotony. Each dwelling has a frontage of 24 ft. 4½ in., and a depth of 17 ft. for the main building, with a projection of 6 ft. for a length of 12 ft. at the rear of the

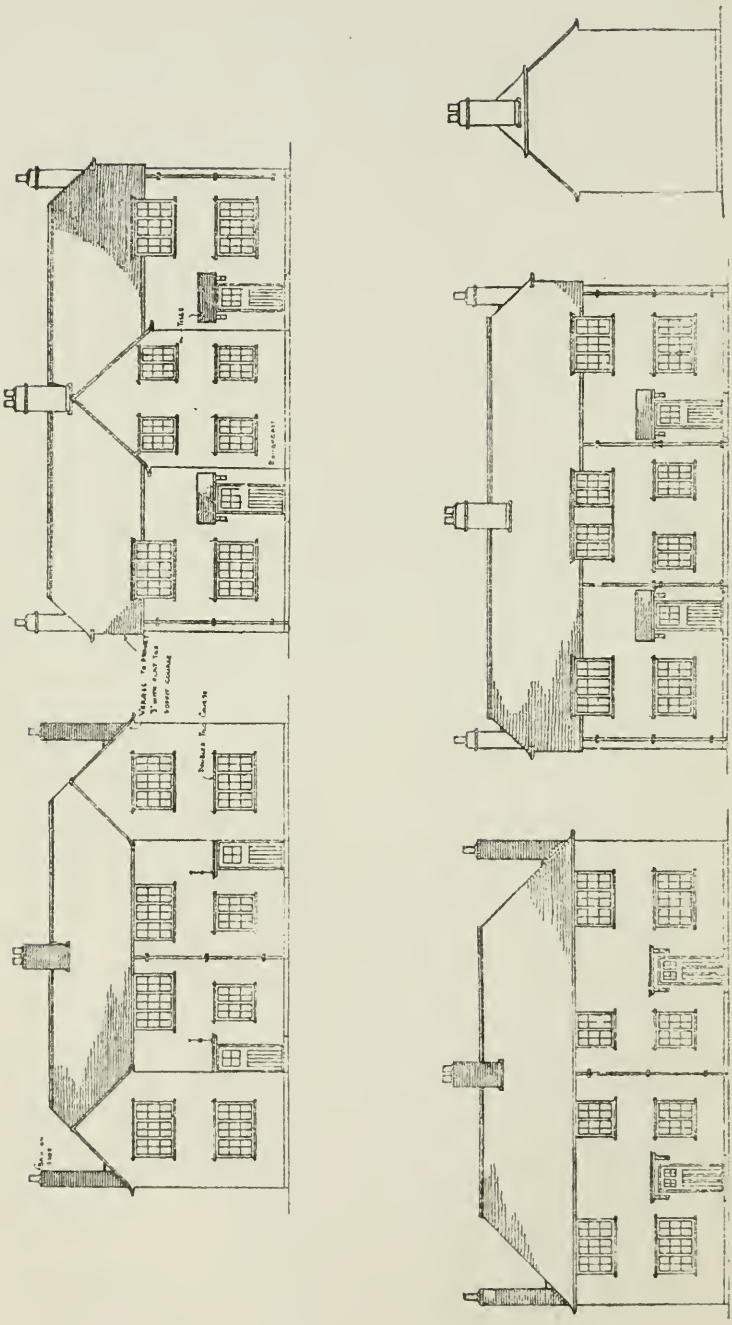
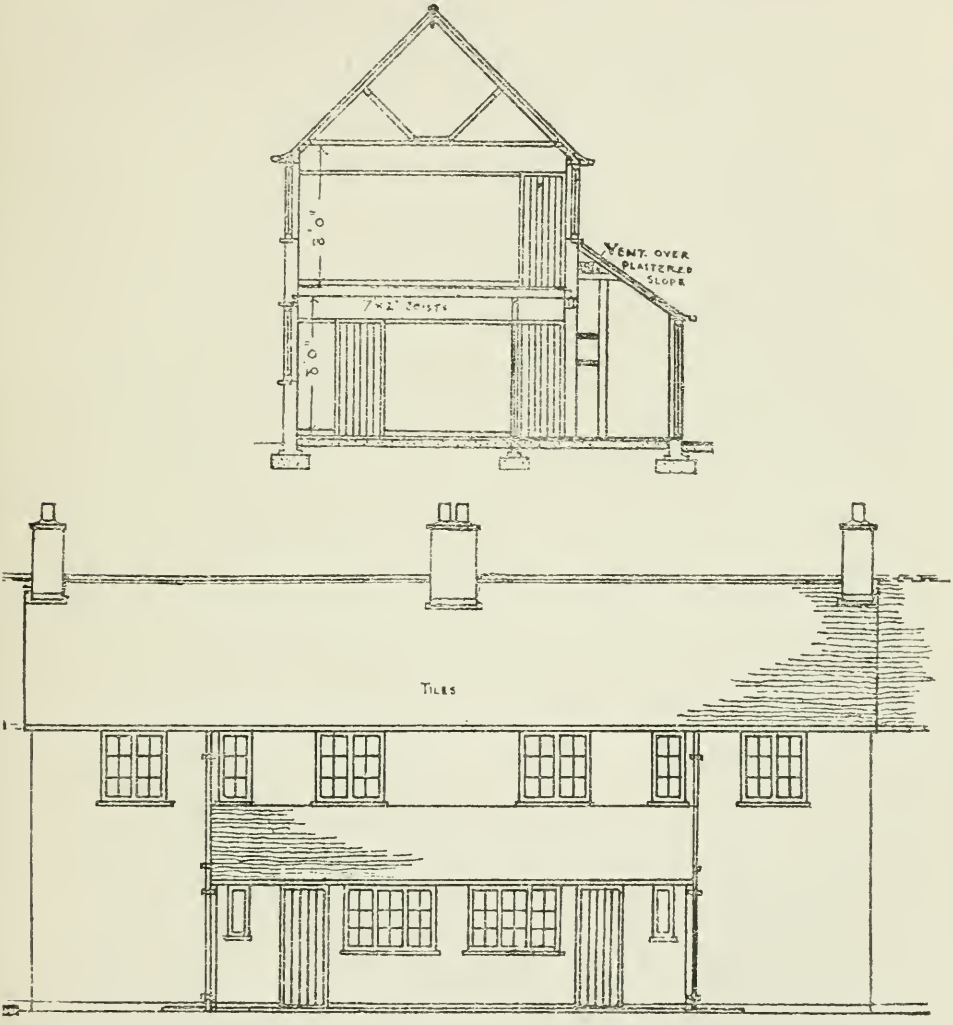


FIG. 18.—TYPES OF FRONT ELEVATION OF COTTAGES AT CRAYFORD.

ground floor. The accommodation on the ground floor consists of a living room 15 ft. 6 in. by 11 ft., a parlour 12 ft. 4½ in. by 9 ft., a scullery, containing bath, a larder, w.c., and fuel store, and on the first floor three bedrooms are provided, the largest being 15 ft. 6 in. by 9 ft. and the smallest 8 ft. 3 in. by 7 ft. 9 in.



FIGS. 19 AND 20.—CROSS SECTION AND BACK ELEVATION OF COTTAGES AT CRAYFORD.

Each floor has a height of 8 ft. in the clear, and the disposition of the rooms is shown in the plans illustrated in Figs. 16 and 17.

The contract cost per cottage erected with concrete blocks, without extras, works out from £175 to £179, and it is interesting to note that the same contractors' price for the brick cottages was £15 more than this per cottage. The difference in cost amounts to a considerable sum when applied to the whole

scheme, and there is no doubt that with the methods employed in this instance the concrete block construction is superior to the brickwork. The extras refer to gables and hipped roofs necessary to secure external variation. The cost of these is proportionally moderate.

The external walls are constructed with a thickness of 9 in., the concrete blocks being 9 in. by 9 in. by 16 in., and they are built directly on to the concrete foundation, which is about 2 ft. wide and 9 in. thick. The internal divisions are all built with $2\frac{3}{4}$ in. breeze concrete partition slabs made on the same machines as the concrete blocks. The whole of the chimney breasts, flues and stacks are built with the blocks, blocks being moulded for the flues, and different sizes being employed to give the necessary bond. The gables are also finished at the top course with blocks having one end splayed to suit the pitch of the roof, and by this method the "racking back" is performed without the introduction of small filling pieces, which are generally employed in inferior work. The window and other openings are generally spanned by a wood lintel, but relieving arches composed of the blocks are built over same to take the superimposed load and transmit it direct to the wall on either side of the openings. Splayed blocks were used in many cases to avoid sharp angles at the sides of openings in the interior of the building, and no trouble has been spared in those minor details which affect the character of the finished structure. The bedroom floor is constructed with ordinary wood joists boarded on top and plastered below, and the ground floor is finished with boarding fixed to splayed fillets bedded in the surface concrete.

The whole of the exterior walls and chimney stacks are rendered with cement and sand containing a waterproofing material, and finished with rough-cast, thus eliminating any possibility of dampness penetrating the walls, these being only 9 in. thick, and not built of blocks moulded with concrete gauged to give the maximum resistance to percolation of water. The whole of the interior walls are plastered, with the exception of the scullery, in which they are finished with distemper applied directly to the concrete blocks, and the appearance is very satisfactory.

Various photographs of the work at different stages and after completion are given in the photographic views, and it will be seen that the appearance is quite satisfactory from the artistic point of view, although the elevations are extremely simple. It will, of course, be obvious that, in cases where the walls are finished with rough-cast, as here described, the appearance is the same as that obtained with brick buildings which are treated externally with the same material, and the concrete block construction is cheaper and undoubtedly stronger.

The blocks employed in the work are made with a mixture consisting of five parts of ballast and one part of Portland cement. The ballast was obtainable in the vicinity of the site, and merely required screening to remove any large stones which would not pass a $\frac{3}{4}$-in. mesh, as it was very clean and contained a satisfactory amount of good sand. The blocks were moulded semi-wet and allowed to season for a minimum period of fourteen days before being built in the work, and they have a much longer period when in position to harden before being

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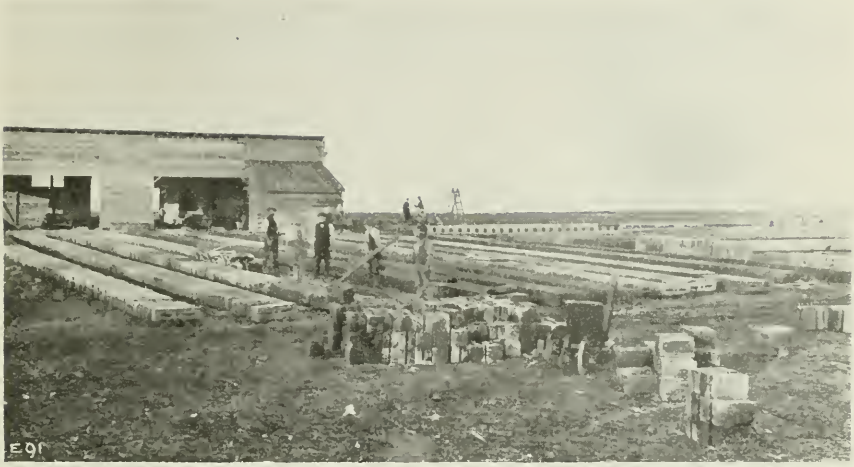

FIG. 21.—BLOCKS LAID OUT FOR SEASONING, CRAYFORD.

FIG. 22.—A COTTAGE AT CRAYFORD, KENT, BEFORE ROUGH CASTING.

FIG. 23.—A PAIR OF COTTAGES AFTER COMPLETION AT CRAYFORD, KENT.

To face p. 29.

covered up. No wetting of the blocks was necessary during seasoning up as the weather was excessively wet, and in fact the work was executed during the worst possible weather conditions.

The blocks also required to be protected during the frosts, and in spite of adverse conditions they are very sound and strong. It is roughly estimated that 80,000 blocks were required for the first 50 cottages, and the whole of these were made on the site with four machines supplied by Winget, Ltd., 25, Victoria Street, Westminster, S.W.

Endeavours have been made to construct cottages for £150 each, and Mr. St. Loe Strachey, the Editor of *The Spectator*, to whom we are indebted for our illustrations, brought forward an instance where he has had cottages erected with concrete blocks built for his gardeners at that figure. We reproduce below the letter which appeared in *The Spectator* in which Mr. Strachey gives his personal experiences of these buildings :—

"The question of the cheaper housing of the people in rural districts—the problem of the cheap cottage—is still with us. Indeed, it may be said that it is destined to become more acute. There are signs that we shall obtain, owing to various agencies, a considerable increase of small holdings. But new small holdings require houses and buildings for the small holders. Meantime the spread of industries, great and small, into the country is increasing the demand for cottages. May I give your readers an account of how I was able to build a pair of cottages for £300—that is, for £150 each.

"The first thing to settle upon was a form of construction which would be cheap, and at the same time durable. Luckily for me, a local builder of intelligence had visited the first Cheap Cottages Exhibition, held at Letchworth in 1905. What he saw there induced him to adopt the system of building with concrete blocks, and he designed for himself a cheap but very practical machine which turns out excellent blocks (composed of Portland cement and gravel) 18 in. long, 9 in. high and 9 in. thick, with two square holes in the middle, holes which practically make the wall a hollow wall. These blocks are not only in themselves cheaper than a group of bricks of equivalent bulk, but they have the advantage of very greatly decreasing the builder's labour bill. The use of so large a unit, though it is a unit not too big for a man to handle, especially if he has the help of a little simple tackle, makes the walls 'rise like an exhalation.' Another advantage is that the cost of haulage is distinctly lessened. The house arrives on the site in the form of a big heap of gravel and a great many bags of Portland cement. All that is then wanted is a good supply of water. The next thing is to bring the very simple block-making machine, which can come upon a hand-cart, and to set to work to make the blocks, which can best be described as giant cement-bricks. The making is very easy, and can be done by unskilled labour as long as the labourers are conscientious as to the manner in which they mix the material. The blocks, as soon as made, are ranged in rows round the foundations of the house, which are dug out in the usual way. The concrete blocks are in a month quite set enough to build with, and the process of hardening them goes on rapidly. The inside wall, even if left by itself as it is in the scullery and other offices, is by no

means impossibly rough ; but in the living rooms it is, of course, covered with a hard plaster, which goes direct on to the wall. The inside partition walls are built with thinner cement blocks.

"It will be noticed that the chimneys are all grouped together in the middle of the house, an arrangement which is economical not only of blocks in the building, but of fuel in the future. Also the staircase rises out of the kitchen-sitting room, and is not boxed in. This is done in order to increase the air space of the room and to save charges. The greater part of the visible woodwork outside is tarred, but the actual window frames are painted.

"The chief objection which will be raised to the house is that there is no sitting room or 'front room.' I admit that I expected that this would prove a source of difficulty, but I am glad to say that it has not proved so. As a matter of fact, the scullery is so near that everything except the application of the heat to the meat is performed in the scullery.

"I add my builder's account. It will be seen that practically there is no profit for the builder, and I must acknowledge with thanks my builder's loyal co-operation with me to keep the price down. Of course, one cannot expect builders to work for a possible profit of about 1½ per cent., but in many cases it is not necessary to allow for a builder's profit. On a great number of estates the cottages are built by the estate masons and carpenters. My contention is that in these cases landlords who will take the trouble to study economy in every particular can build thoroughly comfortable and sanitary cottages for £150, or rather pairs of cottages for £300. I may add that I had to buy the gravel for the blocks at a neighbouring gravel pit and have it hauled to the site. If the site on which the cottages had been built had either been 'sharp' sand or gravel, the blocks could have been made from the material dug out of the foundations. In that case the total cost might have been reduced by £16.

"Approximate Detailed Net Cost of each Part of the Work.

	£	s.	d.
Making plans and setting out cottage	2	10	8
Digging gravel and sand, and haulage to site	16	2	0
Making the concrete blocks, including cement	65	15	2
Digging footings, building walls, including cement	30	17	3
Making doors and windows, including timber and fittings	35	7	1
Framing joists and floors, partitions and roof, including timber ..	52	15	5
Tiles for roof and lead for gutter and fixing ditto	23	6	1
Making and fixing stairs and linings and shelves, including materials	13	19	7
Lathing and plastering, including materials	31	11	9
E.C. fittings, sinks, coppers, cooking stoves, grates, eaves-guttering and pipes, and staining and varnishing	13	2	5½
Builder's profit, to cover use of tackle	5	12	6½
	£300	0	0"

In districts where bricks cannot be cheaply obtained, and in cases, too, where there is a heavy cartage required on materials from the local station, concrete has a distinct field of usefulness. In such conditions, too, it is not always possible to use stone, and, indeed, where local stone is obtainable, the

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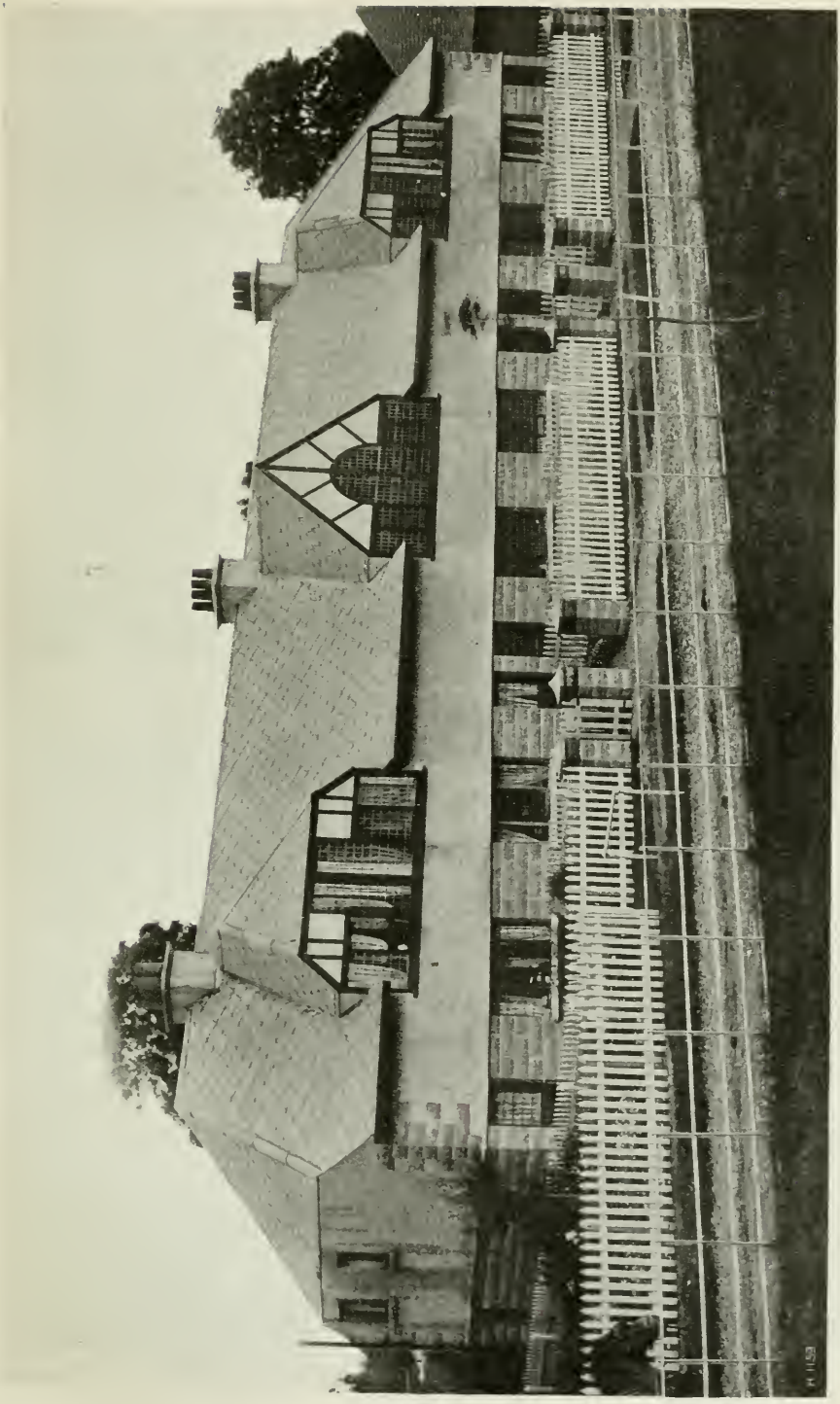

FIG. 24.—COTTAGES AT TALBOT'S INCH, KILKENNY,

To face p. 31.

FIG. 25.—MR. ST. LOE STRACHEY'S COTTAGES BUILT OF CONCRETE BLOCKS.

FIG. 26.—A WORKMAN'S BUNGALOW DWELLING.

cost of dwellings is often very high. In all such circumstances, without exception, suitable aggregates can be obtained for the making of concrete, and the only cartage that has to be done is that of the cement, timber and fittings. A small moulding machine for blocks can be carted to the site, and blocks quickly and cheaply turned out. Mr. St. Leo Strachey's example of how to build a concrete house at £150 is of material service, because it is applicable in any part of the country.

Following this subject of suitable cottages for agricultural labourers, an illustration of a workman's dwelling of the bungalow type is given in Fig. 26 which was constructed of brickwork. This example has particular interest, because it shows the application of reinforced concrete in the construction of a flat roof. This was constructed of reinforced concrete 4½ in. thick, and forms an excellent tie to the walls. The cills are of concrete, also the window and door heads. The eaves project 15 in., and the roof pitches to one point, the rain-water being thus taken off by one down-spout. The low cost of this roof effected a great saving over any other durable material. The whole of the cottage area was covered with 6 in. of cement concrete. The by-laws permit the use of lime concrete for this purpose; but considering the cheap price of cement nowadays and its far superior qualities, it is the general custom to apply Portland cement concrete, and lime concrete is falling into desuetude.

The cost of the cottage was £160, including foundation work. Repairs, rates and ground rent are charged at £2 5*s*., and this, with interest on the loan, would allow for a rent of 3*s*. 6*d*. per week. There are three bedrooms. In this case also the kitchen and sitting room are combined (19 ft. by 14 ft.), and there is a washhouse at the back.

The dwelling in question was built by Mr. Fred Ballard, of Colwall, Malvern, who is a member of the Herefordshire County Council Small Holdings Committee and Health Committee.

Fig. 27 shows some cottages erected at Wrotham, Kent, which are very satisfactory both in appearance and construction.

One pair of cottages was designed by Mr. Arnold Mitchell, and the cost of same is £138 each. The accommodation comprises two living rooms, 9 ft. 3 in. by 8 ft. 3 in., and 14 ft. 8 in. by 9 ft. 3 in.; a scullery, 8 ft. by 8 ft.; and there are three bedrooms measuring 11 ft. 3 in. by 8 ft., 7 ft. by 8 ft. 9 in., and 15 ft. by 8 ft. 3 in. respectively.

Two pairs were designed by Messrs. Stanley Barrett and Driver. These have worked out at £156 per cottage, and the ground floor of each contains two living rooms, 9 ft. 9 in. by 9 ft., and 12 ft. 9 in. by 12 ft.; further, a scullery, 8 ft. 6 in. by 8 ft.; and on the first floor there are three bedrooms, measuring 15 ft. 9 in. by 9 ft., 9 ft. by 8 ft., and 12 ft. by 7 ft.

Two pairs were designed by Messrs. McDermot and Co., and cost £183 each cottage. The accommodation here comprises two living rooms, 11 ft. by 10 ft. and 11 ft. 9 in. by 13 ft. 11 in. respectively; further, a scullery, 5 ft. 6 in. by 7 ft.; and three bedrooms of the following dimensions, 16 ft. 9 in. by 9 ft., 10 ft. 2 in. by 8 ft., and 13 ft. by 8 ft. 6 in.

The remaining two pairs were designed by Mr. Pinkerton and cost £196 each cottage. These contain a living room, 10 ft. 8 in. by 10 ft. 4½ in.; a kitchen, 12 ft. 6 in. by 13 ft. 6 in.; a passage, 5 ft. 9 in. by 10 ft. 8 in.; a scullery, 4 ft. 9 in. by 12 ft.; and three bedrooms, 10 ft. 8 in. by 13 ft., 11 ft. 3 in. by 8 ft., and 9 ft. 6 in. by 10 ft.

All the cottages were erected entirely of concrete. The outside walls were built of 9-in. hollow concrete blocks made on an American block machine and on a "Winget" machine supplied by Messrs. Winget, Ltd., of Newcastle-on-Tyne. The inner walls were built of concrete slabs made partly on a "Winget" machine and partly on a "Perfection" machine.

The blocks and slabs were made on the site, and consisted of three parts breeze, 2 parts sand and 1 part cement. The outside walls were cement and lime rough cast.

The ground floors were finished with 1-in. floor boards nailed on direct to the pitched and tarred breeze concrete.

All the cottages were roofed with red "Record" concrete tiles, also made on the site on a "Record" machine. It is stated that the low cost of the buildings was to some extent due to the use of these tiles, which are made of 2 or 3 parts clean sharp sand and 1 part cement. It is stated that they have proved waterproof and stormproof.

The illustrations, Figs. 28 to 31 show some cottages built at Whitlingham Sewage Farm, Norwich, of concrete. The blocks were moulded on the site on a "Winget" machine, the gravel being raised on the farm. The cost of the cottages was about the same as if they had been built of local bricks, perhaps somewhat less. Approximately the total cost, including the blocks, was about £1,700.

All the walls are hollow. There has never been a vestige of damp in any of the cottages since they were built. They were completed some years ago.

The cottages were designed by Mr. Arthur E. Collins, M.Inst. C.E., City Engineer of Norwich.

Concrete in Situ.

The second type of concrete walling was given as that filled in between shuttering built up *in situ*, either as plain or reinforced concrete.

Although the method has not been so extensively employed as that of building with blocks, it has been adopted in some cases for cottage work with great success, and it is claimed by some designers to be cheaper than ordinary block work.

The chief item in determining the cost, however, is that of shuttering and it will not prove economical unless more than one cottage is to be erected, and the shuttering can be used several times in repetition work. In a large scheme, where many cottages of the same size and type are to be constructed, and the forms are economically designed with proper regard for demolition and re-erection, there is every possibility of the system proving cheap and efficient, especially when there is a good supply of suitable aggregate available in the immediate locality.

The loads to be carried in cottage work are so small as to be practically

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FIG. 27.—COTTAGES AT WROTHAM, KENT.

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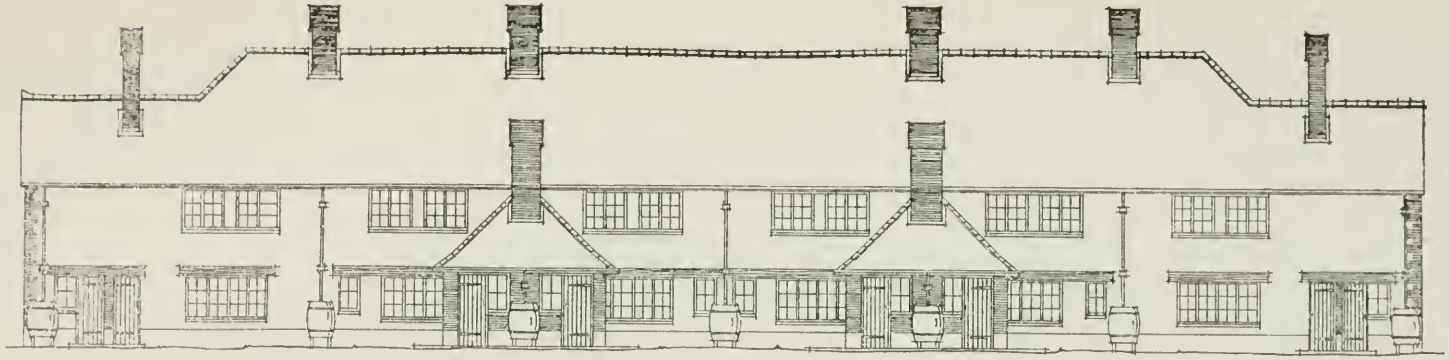
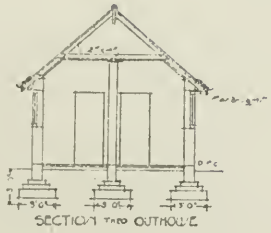
FIGS. 28 AND 29.—CONCRETE COTTAGES, WHITLINGHAM, NORWICH.

FIG. 30.—CONCRETE COTTAGES, WHITLINGHAM, NORWICH.



BACK ELEVATION.



1ST FLOOR PLAN.

ROOF PLAN.

FIG. 31. CONCRETE COTTAGES AT WHITLINGHAM,

negligible, and thus reinforcement is not required from the theoretical standpoint, and calculations for beams, columns and panels to carry definite loads—as they obtain in factory and similar work—are not made. The question of the use of reinforcement has to be dealt with, however, from the practical aspect, as a preventative for cracks which are liable to occur if large surfaces of thin plain concrete are exposed to changes of temperature ; and for this reason it is advisable to insert a certain amount of steel in the form of small rods, wire or expanded metal. The reinforcement need not be anything but a very small percentage of the concrete used, and if small rods are used they will be spaced at wide distances. At all junctions of walls a certain amount of tie should be given, and it is advisable to put some steel at the corners of door and window openings where these occur, as such places are often sources of weakness as regards cracks. Ordinary barbed wire has been successfully employed as reinforcement in some cottage work, and, generally speaking, any material from $\frac{1}{4}$ in. diameter steel rods down to hoop iron may be used, according to the position in the work. The maximum size required will be $\frac{1}{2}$ in. diameter rods, and these will only be used for a few special purposes, such as lintels and any case where loads have to be provided for.

Foundations to External Walls.—The foundations to the external walls are usually formed with mass plain concrete, filled into the trenches in the ordinary manner, and no special type is adopted or reinforcement used.

If the walls are to be reinforced, however, the vertical rods should be carried down into the foundation concrete or short lengths should be inserted before the concrete is set and left projecting upward to ensure a good connection between the wall and foundation.

Thickness of Walls.—The thickness of wall required will depend on various considerations, apart from any question of bye-laws, such as (*a*) nature of materials available for concrete ; (*b*) whether building is in very exposed situation : and (*c*) nature of surface finish, to be applied to the wall, if any. The essential point is, of course, that of making the wall weather-tight, and it will not matter if the wall is 6 in. thick or 12 in. thick if the concrete is badly proportioned and mixed, and is of a porous nature, because it will not be satisfactory. It is absolutely necessary to employ good concrete which is proportioned and mixed to give a dense mixture, and this must be filled in and thoroughly tamped. Generally speaking, the thickness will be from 4 to 6 in., and provided the work is properly executed the walls will be weather-resisting without the addition of any surface coating or special water-proofing compound. The addition of piers at the angles and other suitable points is helpful, and they can be introduced to improve the design if considered in conjunction with the elevations of the whole building.

When piers are employed the panels between can be constructed with concrete 4 in. thick only and will be found quite satisfactory if a little reinforcement is added. Door and window frames should be cast in the work as it proceeds, as this will save expense in the shuttering and they will be securely fixed, especially if a few strips of hoop iron are attached or nails are driven in and left projecting so as to come in the concrete when it is set.

As before stated, reinforcement should be introduced in the walls for the sake of preventing cracks, more especially in large areas. This reinforcement may consist of light expanded metal or rods in the slabs, and where the latter are employed they may be $\frac{3}{8}$ in. diam. or $\frac{1}{4}$ in. diameter spaced at 18 in. or 24 in. centre both horizontally and vertically. They should be hooked at the ends and attached to vertical rods in the piers when the latter occur and the vertical rods should be attached to the foundation concrete as before-mentioned.

Two $\frac{1}{2}$ in. rods should be placed horizontally over each opening and extend at least 6 in. on each side beyond the jambs, and diagonal rods should be placed across the corners of such openings as near to the frame as possible. In all cases of reinforcement for cottage work it is inadvisable to use large rods as they are unnecessarily expensive and they will not be as effective as smaller steel spaced more closely. Where a bearing for a wooden plate or other member is required

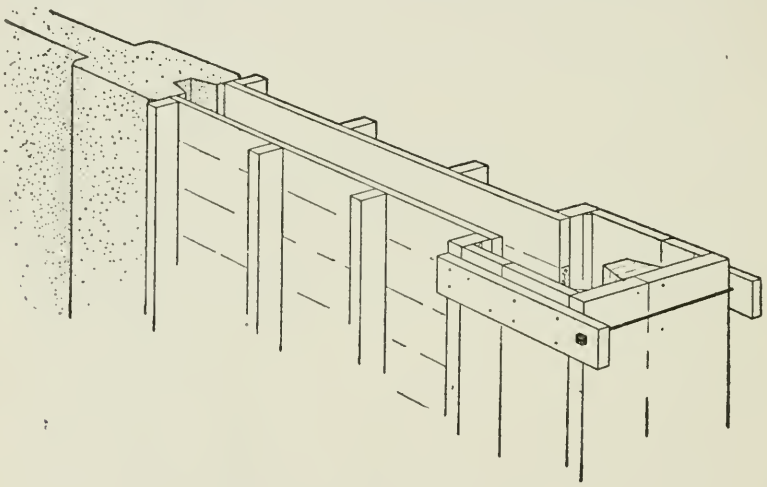


FIG. 32.—SHOWING SHUTTERING.

this should be formed by casting a small projecting course at the same time as the remainder of the wall and some of the reinforcement should be bent so as to come within such course.

Any other projections required, either for appearance or for such purposes as supporting the gutter, should be treated in a similar manner and the whole structure will then be homogeneous. The flues and fireplaces can also be cast in concrete, when necessary, or they may be built of concrete bricks when the design is of such a complicated character as to make the cost of shuttering prohibitive, but in the latter case it is a good plan to provide a bond between the walls and the bricks by leaving a certain amount of projecting rods in the former which can be built into the joints of the latter.

Shuttering.—The shuttering is a very important item and must be carefully considered if the work is to be economical. It must be the essence of simplicity and capable of demolition without being damaged, while sufficiently stiff to prevent bulging when the wet concrete is deposited. The type generally found most

suitable consists of vertical posts, well secured at the foot, spaced at distances apart up to 10 ft., with the minimum number of struts and ties to keep them rigid.

To the sides of these small fillets are screwed, into which boards, 1 in. thick, can be fitted horizontally, these being cut to fit easily and placed in position as required. The boards are stiffened, when the maximum length is employed, by small vertical ledges about 3 in. by 2 in. placed on the outsides of the shuttering and connected by cross bolts $\frac{1}{2}$ in. diameter with loosely fitting nuts. At the bottom of the wall a hole is bored in the boards for the bolt to pass through, and at the top of each section the bolt passes over the topmost board.

The concrete is filled in for a height of four or five boards and allowed to set sufficiently when the fillets are unscrewed, the boards withdrawn and raised to the height required for the next section. The holes through the concrete caused by the bolts connecting the ledgers can be filled up with cement and sand well driven in. The posts should be in one length and where of any height should be tied horizontally by light braces, carried from post to post, at intervals in the height.

There is no waste in forms of this type, especially where bolts and screws are employed for the connections, and the material can be used repeatedly without additional cutting if the work is standardised and the structures are a repetition. Generally speaking, the carpenter who is inexperienced in forms for concrete, makes the error of using too many nails in fixing the work together, with the result that it is difficult to remove them where the concrete is set without damage to the walls and the wood is invariably spoilt.

Internal Partitions.—In the case of internal partitions in this class of structure it will not prove economical to erect shuttering and cast them *in situ*, and there is no necessity to execute the work in this manner, because there is no question of making them weatherproof, and ordinary concrete partition slabs will prove inexpensive and satisfactory or metal lathing and plaster may be used, according to the requirements to be fulfilled as to weight carrying.

Some actual examples of the application of reinforced concrete in domestic work are given in the following notes and illustrations (Figs. 33 to 36) which deal with some bungalows erected at Carnegie, a suburb of Pittsburg, from the designs of Mr. W. H. Parish, of Carnegie, Pa., U.S.A.

Each bungalow contains five large rooms and bathroom on the ground floor and two rooms on the first floor.

The cellar walls are 8 in. thick, of monolithic concrete ; a 4 in. plate is laid flush with the inner side of this wall, upon which the joists have a 4 in. bearing ; another 2 in. by 4 in. plate is laid upon and spiked to the joist, and upon this plate the studding (2 in. by 4 in.) is placed 16 in. on centre. Between these studs is placed a form, $1\frac{1}{2}$ in. thick, flush with the inside of the studs, and held in place by 1 in. strips at the top, middle and bottom of the studding. These forms are removed when the concrete has set, leaving a $1\frac{1}{2}$-in. air space between the concrete and the lath and plaster, which is ultimately placed on the studs. A space of $2\frac{1}{2}$ in. is thus left between the inside form and the outer edge of the studding, and there is a space of 4 in. on the cellar wall between the outer edge

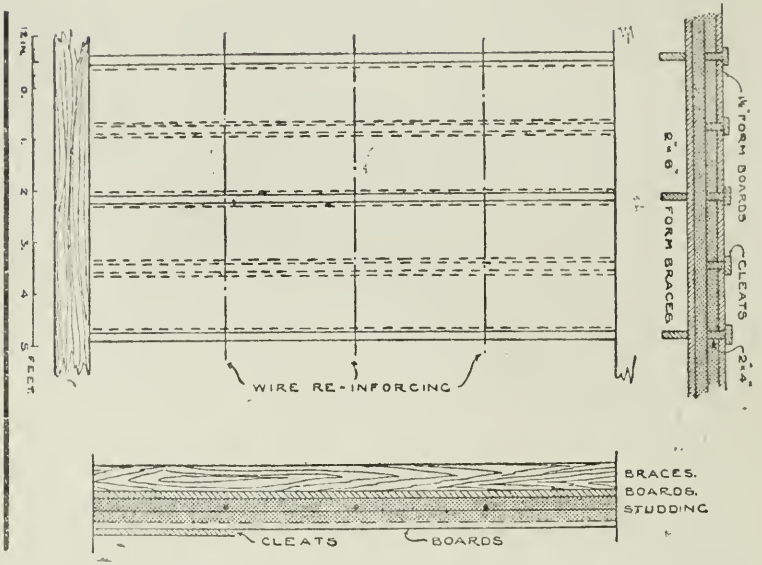


FIG. 33.—SHOWING METHOD OF BUILDING AND REINFORCING WALLS.

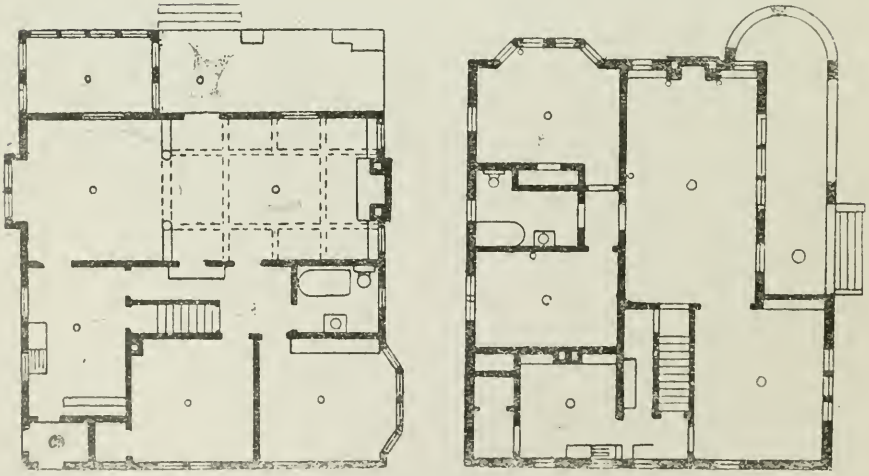


FIG. 34.—FIRST FLOOR PLANS. REINFORCED CONCRETE BUNGALOWS, CARNEGIE, PA., U.S.A.

To face p. 38.

FIGS. 35 AND 36.—REINFORCED CÓNCRETE BUNGALOWS, AT CARNEGIE, PA., U.S.A.

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FIGS. 37 AND 38.—CONCRETE COTTAGES ERECTED ON MESSRS. ROWNTREE'S ESTATE.

of the 2-in. by 4-in. frame and the outer edge of the cellar wall. An inch form is rested on the cellar wall, held in place by a 2-in. by 6-in. timber placed opposite each studding and held in place by a wire which passes around the studding and is held 3 in. from the studding by a spacing block, which is removed as the concrete is put in. This makes a wall $2\frac{1}{2}$ in. between and 3 in. outside of the studding, or $5\frac{1}{2}$ in. thick, which gives a wall of a total thickness, including the plaster on the inside and the outside, of 8 in.

The outside wall is plastered after the forms have been removed. In order to prevent cracking an angle iron 2 in. by 2 in. should be placed over each opening, as the wood frames are not rigid. A No. 9 gauge wire is passed entirely around the house and stapled to each stud, one below the windows, one halfway up, and one above the windows, thus embedding the wire in the centre of the concrete.

The concrete is mixed in proportion of one cement, three sand, and six machine slag, and all the water that it will carry. The plaster used on the outside is in proportion of one cement and two of sand, with sufficient lime putty to render it plastic and readily trowelled.

The window and door frames are fitted in position before the forms are placed, and great care is exercised to see that every space is filled with concrete.

The later houses are being constructed with concrete chimneys, with terra-cotta flue linings, which is found to be much cheaper and better than brick, These houses are heated with hot air furnaces at a cost not to exceed £5 per year.

The cost of construction was little more than for a first-class frame house.

Concrete Moulded Horizontally.

The third method of wall construction consists in filling the concrete into large horizontal moulds so that one side of the complete structure is formed as a large slab, and this is raised into its vertical position when sufficiently hardened.

This system has been used for cottage construction in some parts of the country, and it has some advantages over the method of casting concrete *in situ.*

The shuttering is more simple, and very light timber may be used. The concrete does not require to be hoisted to any height worth mentioning, and the placing of the reinforcement is extremely simple. In casting the slab it is also an easy matter to obtain such a good surface to the concrete that no plastering whatever is required on the inside faces of the walls, and thus considerable expense is saved.

The shuttering will consist merely of a level staging, for which purpose the reverse sides of floor or roof boards may be used ; and on this the window and door frames are laid in the correct positions. The concrete is then deposited and screeded off to the right thickness. Where reinforcement is employed, this is laid in position before concreting, and kept secure by one of the many methods used in floor work.

Any projections required for the bearing of floors are cast at the same time

as the mass of the wall, and the ends of all reinforcement are left projecting beyond the concrete, to enable a satisfactory connection to be made at the junctions with other walls. The surface of the concrete can be trowelled off before the final setting takes place, or prepared in any way for the final skimming of plaster. When the slab is thoroughly set it is hauled up to the vertical position, and the projecting ends of the rods are linked to those of the adjoining slabs, and the corners are made good with concrete.

In some cases the platform on which the wall is cast is raised some feet above the ground, so that it can be turned about a fulcrum in the middle, and the lower edge of the slab brought down to the concrete foundation while the top edge is being raised to the required height, this method being safer than that of raising the whole wall from the ground level.

In the external walls the minimum thickness employed is usually 4 in. and the maximum for piers and similar features is 6 in.

In the evidence given before the Departmental Committee on the Equipment of Small Holdings, it is interesting to note that one witness stated he had built a house on this principle which was ready for occupation and furnished within twelve weeks from the laying of the slab, and the walls worked out at 6d. per square yard less than the cost of 9 in. brickwork. This witness has also built a concrete bungalow cottage designed to pass the bye-laws of York. All external and internal walls are of concrete, as also is the flat slab roof, which is reinforced with $\frac{3}{16}$ in. barbed wire. The cottage contains three bedrooms, large living room with cooking range, scullery, pantry and coal place and separate bathroom.

The cost of this cottage, which was a detached one, was £90 for labour and material, without profit. Some illustrations of the building, which was erected on Messrs. Rowntree's Estate, are here given, and some notes as to methods employed will be of interest.

The general arrangement of the rooms is shown on the plan, Fig. 39, and the appearance of the finished structure can be seen in Figs. 37 and 38.

The external walls are 9 in. thick, this being the minimum allowed under the York bye-laws, and they are built of blocks cast in moulds as shown in the photograph in Fig. 37. The method of obtaining a rough cast finish was procured by putting a thin layer of sand at the bottom of the moulds, embedding into it some sharp clean basic slag, and then about 4 in. of good solid gravel concrete. The mould was then filled up with concrete composed of clean screened boiler ashes.

The ash concrete was used for two purposes, firstly, because it was cheaper than the gravel, and secondly, because it forms a good surface for skimming over with plaster, and prevents condensation to the walls. The same course is adopted for the reinforced concrete flat roofs and is worthy of comment. When making the slab, at least 1 in. of good ash concrete should be put down and covered over immediately with the gravel concrete. This gets over any difficulty experienced with extreme variations of temperature. The internal walls were made entirely of ash concrete $2\frac{1}{2}$ in. thick, and a mould and sample block are seen in the photograph referred to in Fig. 51. The foundation was constructed with a 4 in. concrete slab over the whole site, composed of good gravel concrete, and the

sides were brought up the width of the walls, to 6 in. above the ground level. This gave a raft which is similar to an inverted box lid. After two days' setting, the laying of the blocks for the walls was proceeded with. The windows were built in as the work proceeded and the walls were finished on the inside with a skimming coat of lime putty gauged with plaster of Paris. The fascia at the top of the walls was formed with solid concrete in order that small pieces of steel could be cast in for stretching and attaching the wires used in reinforcing the roof.

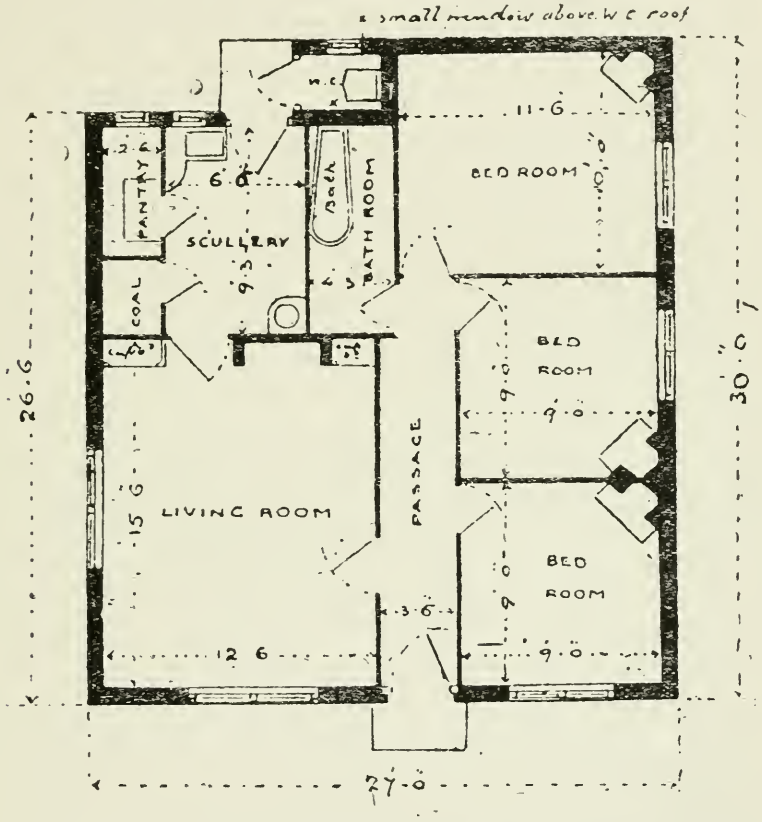

FIG. 39.—PLAN OF COTTAGE ERECTED ON MESSRS. ROWNTREE'S ESTATE.

The chimneys were very carefully worked out to prevent down draughts, by providing adequate openings on each side, covered with a concrete slab.

The whole of the work was designed by Mr. J. Swain, architect, and executed under his supervision.

An example such as this indicates the possibility of concrete construction for cottage work, and with good supervision the structure will prove to be weathertight and lasting.

An example of a building erected with slabs moulded horizontally as here given is described and illustrated on page 72 (Farm Buildings).

Concrete Poured into Iron Moulds.

The fourth method of constructing the walls was given as that of pouring concrete in a more or less liquid state into wood or iron moulds erected complete to the form of the structure. This method is, of course, closely allied to concrete *in situ* and forms part of this class of work, but it has some distinct features of its own. It has not been employed to any great extent, and it is not likely to become general as there are some serious disadvantages. The most notable example of this type of construction is that adopted by Mr. Edison, who has invented a system whereby an iron mould of the whole cottage is set up and the building made by pouring the liquid concrete in at the top of the mould, the structure thus becoming a complete monolith.

Some of the advantages claimed are (1) All joints are avoided ; (2) speed of erection ; (3) economy.

It is stated that a cottage can be finished in a fortnight and that a saving of from 20 to 30 per cent. can be effected, but it is doubtful if these claims could be substantiated.

In the first instance the complete mould alone will cost about £1,200, and it will therefore be obvious that a very large number of exact repetitions on the same estate must be carried out in order to bring the cost of the buildings down to a cost comparable with that of concrete blocks. The mere fact of this exact repetition being absolutely necessary is a great disadvantage, as it prevents even the slight variations which can easily and economically be made in other types of construction, and which lend additional interest to a large scheme. There must also be some difficulty in introducing even the small amount of reinforcement which can be considered as necessary in every concrete building, and thus cracks are liable to occur. There is no doubt that parts and features of concrete structures can be economically and satisfactorily standardised, but it is extremely doubtful if the standardisation of the whole building can ever be entirely satisfactory.

Surface Treatment.

The colour and appearance of concrete work is not always satisfactory to the designer, who is endeavouring to produce an artistic cottage externally, objection being made to the somewhat cold-grey and monotonous surface which results if no special treatment is undertaken.

There are, however, methods by which that objection can be overcome and some notes as to these should be useful, but any treatment must be very carefully considered before being undertaken, as it involves a certain amount of extra expense and if not executed in a proper manner the result is liable to be disappointing.

The various methods may be stated as follows :—(1) The selection of aggregate having the desired tint and surface, this aggregate being exposed by treatment after the concrete is moulded. (2) Colouring the concrete by the addition of pigments. (3) Distempering. (4) Staining. (5) Oil painting. (6) The application of a special coating of plaster, rough cast, "stuc," mosaic tiles, or similar treatment. Methods five and six can be generally set aside as unsatisfactory

for various reasons, among which are (*a*) they are expensive; (*b*) they disguise the nature of the material used in the construction and thus the appearance is not a true one; and (*c*) in the case of oil painting the work will not be satis factory unless executed a considerable time after the concrete has been placed, thus preventing the desired effect being obtained when the building is new.

The first-mentioned method, viz., that of using a special aggregate which is exposed, is the one which will give the best results, and it truly expresses the material employed for the structure. The aggregate can be selected on account of its colour or its texture, or both, and it is preferable to employ a material which is characteristic of the locality in which the building is erected. The desired effect is obtained by removing the skin on the outer surface, this being accomplished by removing the forms as quickly as possible and scrubbing with brushes and water until the particles are brought into partial relief. The scrubbing should be done within 8 to 24 hours after placing, depending on the setting time of the cement, the character of the aggregate and the temperature of the atmosphere. Care must be taken in the removal of the forms, the scrubbing must be done immediately, and the surface well rinsed after. In cases where the concrete has become hardened the use of a wire brush is advantageous. Carborundum and water will also give good results on hard concrete, the surface being well wetted and rubbed with the stone until a lather is formed, the work being then washed down and finished off with a finer stone. The surface is also sometimes removed by the use of muriatic acid diluted with six parts of water, which is afterwards thoroughly washed off, but it is preferable to adopt the brushing with plain water as previously mentioned. Sand blasting and tooling are also employed for dressing the surface, but these are expensive and not to be recommended for cottage work.

In the second method, when the concrete is coloured by pigments, considerable care must be exercised because the lime in the concrete will have an injurious effect on the majority of pigments, and the result may be far from pleasing. The selection must be made between the relatively few mineral pigments which include lampblack, manganese dioxide, red iron oxide, English red oxide, brown roasted iron oxide, brown ochre, yellow ochre, ultramarine green, and violet oxide of iron, these being recommended for use by a committee appointed by the National Association of Cement Users (U.S.A.) to investigate the question. The amount that can be safely used without detriment to the concrete is very small, only about 5 per cent. by weight to that of the cement, and in many cases this amount will not be sufficient to produce a marked change in the colour.

Successful effects can be obtained by distempering with common whitewash or with cement washes, and if coloured distemper is used only those pigments given above should be adopted. The alkali in the surface is sometimes killed with dilute acid and afterwards well washed before the application of the distemper to prevent any discoloration.

The fourth method is that of staining, and the material for this can be made up by the person executing the work, or one of the special stains which are on the market can be adopted. Stains have the advantage that they preserve the

natural texture of the concrete as they sink into the pores, they are easily and quickly applied, and are comparatively cheap. A brown stain is made by dissolving iron sulphate in water in the proportion of 2½ lbs. to 1 gallon, and by the addition of a second coat the colour is deepened. If alum is added to the above solution a pale yellow will result, while a green is obtained by the use of chrome alum.

The surface of concrete can also be relieved by the insertion of panels of coloured stone or tiles, which can be introduced purely for ornamental effect and thus they will not give the impression in any sense of acting as a disguise but merely an addition to the material used in construction.

Section III.

FLOOR CONSTRUCTION.

The construction of floors can be divided into the two classes of ground floors and upper floors.

The materials employed in each case may be timber or concrete and the finishing may be boards, tiles, cement or granolithic.

The ground floor may either be formed directly on to the surface concrete or it may be raised on sleeper walls and constructed with wooden joists and boards. The former method will prove by far the cheaper of the two and therefore for cottage work it should be well considered.

In any case the surface concrete must be laid, and therefore it will obviously be economical to employ this as the basis of the floor.

This concrete will be 4 in. or 6 in. thick, the former being sufficient, generally speaking, and there will be no need for reinforcement. Any of the surface finishings mentioned above may be adopted, boards being suitable for living and sitting rooms, and tiles or cement for kitchens, sculleries, larders and such-like apartments.

Granolithic will generally prove a very satisfactory material to use, as it is cheap and sanitary, and if well laid its wearing properties are excellent. The only disadvantage as compared with a boarded surface is that of coldness, and this especially applies in the case of bedrooms, but despite this it will be found eminently suitable for cottage work and is becoming very general in this class of structure.

When boards are used without building sleeper walls care must be taken to prevent them being laid in such a manner that dry rot will occur and this precaution is particularly necessary in cottage work, as the floors are invariably covered with linoleum which stops any circulation of air about the upper surface or through the joints.

The boards are either nailed to wood fillets cast in the surface concrete or they are spiked directly to the latter when breeze is used as the aggregate.

In the first mentioned method the fillets should be splayed to ensure sufficient hold to the concrete and they should be creosoted or treated before insertion. The great difficulty will be that of ventilating the very small space that occurs under the boards as the fillets only project a short distance above the concrete,

and it is this difficulty which has led many designers to abandon the method for that of spiking direct to the concrete.

If the latter method is properly executed it will be found to give satisfactory results, and there are two main points to which attention should be given, viz. (1) the boards should be bedded down solid on to the concrete, and (2) the concrete should be thoroughly dry before the boards are laid.

When gravel or similar concrete is used for covering the surface of the ground a layer of ash or breeze concrete must be laid on the top, and this should be made as level as possible. If it is not perfectly level fine ash may be sprinkled over the area, when required, to prevent any air spaces occurring, and, as an extra precaution the boards may be tarred on the underside before fixing.

The other materials mentioned for finishing the surface of the ground floor are laid in the usual way, and no particular notes on these are necessary. The question of using concrete floor tiles is fully dealt with on page 155.

Upper floors are usually constructed with timber joists and boards, but reinforced concrete is occasionally used and has been proved to be very satisfactory. It would certainly commend itself as the material to adopt when the walls are of reinforced concrete, as attachment becomes a simple matter and the structure is monolithic.

One of the chief difficulties will be that of constructing the floor without the introduction of beams in unsuitable positions, while using thin slabs and comparatively small reinforcing rods, and careful consideration is necessary in designing the floor if economy and suitability are to be obtained.

In the case of cottage floors the load to be carried will obviously be a comparatively light one, and thus the reinforcement required will not be a large amount. Small diameter rods can be employed, and the slabs can be very thin. When boards are to be adopted for finishing the surface a layer of breeze concrete can be laid, as described for ground floors, and the boards nailed down without the introduction of fillets.

When cement or granolithic are employed a small wood fillet is sometimes introduced all round the room at a short distance from the walls, this being kept flush with the finished surface so as to afford a fixing for the carpet.

It is essential to provide a proper bearing for the floors on the main walls and partitions, and in the case of reinforced concrete floors these should be constructed when the work has been built up to the bearing level rather than by leaving chases in the work. When the outer walls are built with cavity blocks, for example, and the partitions carrying the floor are solid blocks $4\frac{1}{2}$ in. thick, then these should be all built up to the necessary level, the shuttering erected, and the floor constructed over the whole area, thus bearing on the full width of the inner divisions of the external walls and being continuous over the partitions. When the floor is sufficiently hardened the upper parts of the walls and partitions are built off the reinforced concrete and a satisfactory structure will result.

This will also prove the most economical method, as the hoisting and placing of the concrete will be simplified and the finished floor will be available for working on when the upper part of the structure is being built up. When reinforced

walls are adopted the floor should also be constructed at the same time in order that the reinforcements may be carried from one portion into the other to form a complete structure.

If the walls are cast horizontally and raised into position when the concrete is hardened the floor cannot be built into the work in the same manner, and it is only possible to obtain a bearing on a projecting portion which has been cast on the walls for this purpose.

When wooden floors are constructed without the use of concrete they are formed in the usual manner and finished with lath and plaster on the underside, and in this last respect they will prove more expensive than concrete floors, as the latter will only require a skimming of plaster in the principal rooms, and in sculleries and such-like apartments no treatment will be necessary if care is taken to provide a reasonably good surface when concreting. Another advantage gained by the use of reinforced concrete over wooden floors is that of a small saving in the height of the building, as the average thickness of the former, when finished, will be about 6 in. as compared with 11 in. in the latter, and although this may not appear to be a very large item, it represents some saving and, therfore, is worthy of consideration in cottage work when cost has to be so carefully considered.

The shuttering for reinforced concrete floors will be a very simple matter, consisting merely of a few boards supported by vertical posts and sole pieces, and occasionally a little beam casing will be necessary. No elaborate trimming or strutting will be needed and no special details of the work are here required, as they can be found in numerous books which are on the market.

Section IV.

ROOF CONSTRUCTION.

Cottage roofs can be divided into two main classes, viz. (1) flat roofs and (2) pitched roofs. The latter are more generally adopted, as with the use of timber only it is economical to be able to frame up and triangulate the members to give the requisite strength, and also they are generally considered more artistic, especially when tiles can be employed as the covering.

As far as first cost and utility are concerned, however, the flat roof will prove superior, especially if designed and executed with proper care. All the bedrooms will also have square ceilings and the sloping portions which almost invariably occur with pitched roofs will be avoided, and no inclined thrust will be put upon the walls as invariably happens, especially when a wooden pitched roof is constructed without sufficient tie.

Flat Roofs.—Flat roofs, constructed with reinforced concrete, have proved very satisfactory when used for cottages, and they are likely to be more extensively employed in the future. Either wire or small rods may be used for the reinforcement, and this should be attached to the walls when the bearing occurs. It is a good plan to form a concrete lintel or beam around the upper part of the wall, even when blocks are used for the latter, this being about 9 or 12 in. deep and the full thickness of the wall, and when this is being concreted

small pieces of steel should be inserted and left projecting slightly above the top in order to provide an attachment for the reinforcement in the roof slabs.

The latter can be stretched from side to side after the shuttering is erected and thus is easily kept in position.

For all ordinary cottages it will be sufficient to make the slabs 4 in. thick with light reinforcement and when stiffening beams are necessary they should be introduced to coincide with an internal partition, or otherwise they are rendered unsightly; or they may be formed above the slab level to give flush ceilings. The latter method will have the effect of cheapening the form work as compared with beams projecting on the underside, but care must, of course, be taken in their disposition to avoid forming a pocket from which it will be difficult to drain off the rain water.

When the concrete is correctly proportioned and mixed with the requisite amount of water only, the roof will be found to be quite watertight without any external coating, especially when a good aggregate is used, and the surface is trowelled over before the final set takes place. When some covering is found absolutely necessary, as may occur if the concrete is not mixed to give the maximum density, it may be applied in the form of a layer of Portland cement and sand mixed in the proportion of 1 of cement to 1 of good clean sand, finished with a metal trowel, but generally speaking, this will not prove so satisfactory if put on when the roof has been finished some time as when applied while the concrete is green, as in the latter case a better adhesion is obtained and cracks are less liable to occur in the surface. There are many methods of covering the concrete, such as with asphalt, lead, patent sheeting, bituminous paint, a patent waterproofing compound or a cement wash, *but it is preferable in cottage work to employ good concrete and avoid the use of any of these as they will add to the cost and should not really be necessary.* This feature in the construction is one which illustrates very clearly how satisfactory results can be obtained with the minimum outlay if the concrete is made with proper care under the supervision of an experienced man, and it is not sufficient to condemn uncoated concrete roofs as being unsatisfactory because some are found which are not watertight. Various examples of flat concrete roofs are given throughout this book, and suggestions for the finish at the outer edges will be found. The concrete may be carried right over the wall and project beyond as a cantilever with reinforcement as necessary, or a blocking course or parapet may be made in concrete to form a finish. When the latter is constructed some of the reinforcement from the slabs should be turned up into the vertical concrete and the whole should be cast as nearly in one operation as possible. Whichever method is adopted the chief aim should be simplicity, both in appearance and construction, and scale as compared with the other features and the building itself.

Pitched Roofs.—Pitched roofs are occasionally constructed with reinforced concrete in cottage work. The sloping sides should be formed as thin slabs with expanded metal or wire reinforcements, supported on reinforced concrete purlins which rest on the external gable walls and also on internal concrete partitions when the span between the former is too large for economical

construction. The slopes should be tied to the concrete walls at the foot and some horizontal rods should be placed at the apex where additional concrete should be provided as a ridge beam, as this horizontal steel will greatly assist in preventing any spreading tendency. It will also greatly strengthen the roof if the ceilings over the bedrooms are formed with expanded metal which is attached to the slabs and extended across the whole span of the roof. As the roof will be visible and form a feature of the building it should be rendered with cement and sand while the concrete is green and the latter need only be 3 in. thick where the slabs occur.

Concrete is also used as a covering to pitched roofs in the form of concrete tiles, and some notes on the manufacture and application of these is given on page 148.

SECTION V.

CONCRETE STAIRCASES.

Concrete is a very suitable material to use in the construction of staircases for cottage work, as it is strong, cheap and hygienic, and it can easily be adapted to any position or type.

The staircase may be cast *in situ*, or built up with separate steps which have been cast in moulds and allowed to harden before using. When reinforced concrete is being employed for the main portions of the whole structure it is preferable to use the material for the staircase and cast the concrete *in situ* with the reinforcement carried into the floors or other adjacent work and a light but strong staircase will be obtained. In the case of buildings erected with concrete blocks and when no reinforced concrete is used it will probably be more satisfactory and economical to adopt the separate steps which have been moulded previously. Endeavour should be made to keep all the work as far as possible of the same nature throughout the structure, as this will greatly facilitate the supervision and secure uniformity of quality which might not otherwise be obtained.

The staircase may be supported by concrete strings independently of any partitions, or it may be entirely carried by the latter, or again one edge of the concrete may be supported by a partition and the other may require a beam which is introduced in the form of a string.

With concrete *in situ* the minimum thickness, which will occur at the internal junction of the tread and riser, should not be less than $2\frac{1}{2}$ in. and the spandril should be formed as a straight slope parallel with the pitch of the stairs, except where winders occur, and here it will be curved. Reinforcing rods should be placed in the spandril concrete close to the under surface, these being about $\frac{1}{2}$ in. diameter, spaced according to the length or width of the flight, the main rods running across the width of the stairs where support is provided on either edge, whether in the form of partitions or strings, and parallel with the length of the flight when support is available at the top and bottom only. The latter condition is one which will seldom occur in cottage work, and it is not usually

economical except in very short flights, as the staircase has to be designed as a slab having a span equal to the length of the flight. To prevent cracks occurring in the spandril when the minimum thickness of concrete is employed it is advisable to introduce some small rods or wire reinforcement at right angles to the main rods, this costing very little.

When reinforced concrete beams or strings are necessary they will be of the

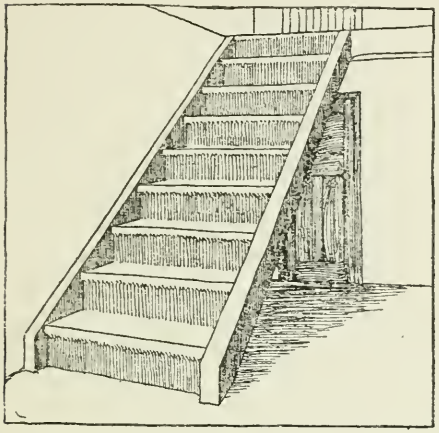

FIG. 40.—A FLIGHT OF INTERNAL STAIRS.

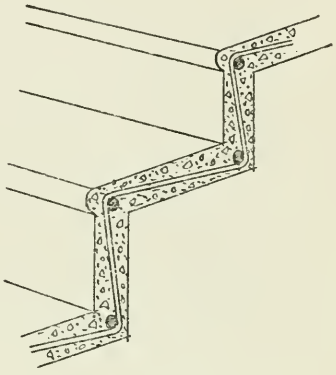

FIG. 41.—REINFORCED CONCRETE STAIRS.

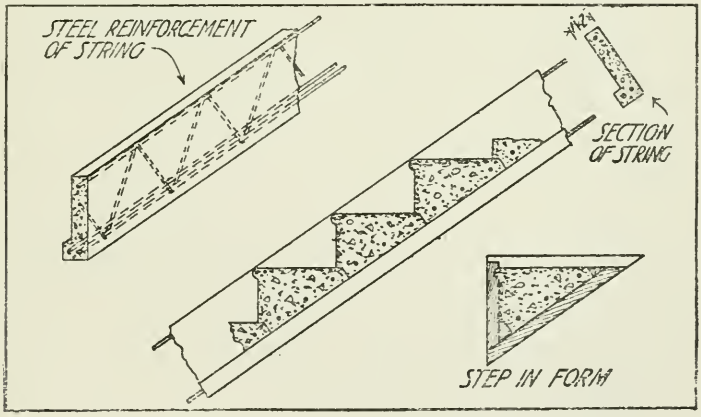

FIG. 42.—CONSTRUCTION OF INTERNAL STAIRS.

"close" type, viz., beams having top and bottom edges both parallel to the pitch of the stairs. The width usually required will be $2\frac{1}{2}$ in. or 3 in. and the depth a little more than is sufficient to cover the ends of the steps. The main reinforcement will consist of two rods about $\frac{3}{4}$ in. diameter, placed in the lower surface, and one rod should be placed in the upper surface with wire binding or links

connecting both sets of steel. When a concrete string is used in connection with steps not moulded *in situ*, it should have a projecting ledge of concrete cast on the bottom edge to form a bearing for the steps. In the case of reinforced steps and strings which are formed in one operation the reinforcement in the former should be carried well into the latter and the ends of the rods turned up into the heart of the concrete of the string.

Very light monolithic staircases can be constructed when the whole is designed with reinforced concrete strings and the treads and risers are both formed as reinforced slabs about 3 in. thick.

The reinforcement generally consists of one $\frac{1}{2}$ in. rod at the intersection of each tread and riser, placed across the width of the flight, threaded with $\frac{1}{4}$ in. rods bent to the shape of the steps and placed about 1 ft. 6 in. or 2 ft. apart. Less concrete is employed, but the shuttering will be more complicated and expensive as the risers require to be moulded between two vertical forms, one above and the other below. The treads will obviously only need one form as the concrete can be struck off level at the top.

Steps which are cast and allowed to harden before being built in should be made with a spandril parallel to the pitch of the staircase, as these make a neater finish and use less concrete than is the case with solid square steps. A square end for the length of the bearing can advantageously be formed when the steps are to be built into partitions, as this makes a stronger job and avoids waste and cutting of the partition blocks. A proper splayed rebate should be formed at the bottom of each riser to give a proper bearing on the step below, this being known as a "back joint" in stone steps. A few small reinforcing rods are sometimes placed in the soffites of the steps at the time of casting, but these are not absolutely necessary unless they are exceptionally long. Cantilever steps must be reinforced with rods in the upper surface when these are necessary, but generally speaking in cottages the underside of the staircase will be enclosed to form a cupboard or coal cellar, and thus bearing at both ends of the steps is easily obtained.

Where landings occur these should be concreted in position with reinforcement on the underside, as only a few plain boards are necessary for the shuttering, and the work will be cheaper to execute in this way than in any other. In designing cottage staircases care should be taken to provide sufficient headroom at every point and the number of steps should be reduced to a minimum. A comparatively small tread and high rise can be adopted, the latter being as much as 8 in. when necessary.

The surface finish for concrete steps of all kinds should be of a hard-wearing nature, and generally speaking the best material to use will be that composed of 1 part of Portland cement and 1 part of granite chippings. This finish should be about $1\frac{1}{2}$ in. thick on the treads and 1 in. thick on the risers. In the case of concrete *in situ* the finish should be applied while the concrete is green to prevent it cracking and breaking off, and in the case of cast steps it should be done at the time of moulding. The surface may be roughened when required, by forming grooves with an indenting roller or other similar tool. For improving the wearing

surface silicate of soda is sometimes employed, this being either applied to the surface with a brush or mixed with the material before it is laid.

The handrail and balusters call for some consideration where concrete steps are used, as the attachment of the balusters to the concrete string or steps is difficult to execute satisfactorily when wood balusters are adopted.

In cottage work it frequently happens that a partition wall occurs on one or both sides of the staircase, and when the latter is the case it is a simple matter to fix a wooden handrail on small iron brackets attached to the partition and no balusters are required.

When balusters are necessary they may be of plain square iron as these can be let into the concrete, or if wooden balusters must be used and there is a concrete string, a wood capping can be screwed to plugs in the concrete and the bottom of the balusters housed into the capping.

Section VI.

WINDOW-CILLS, DOORSTEPS AND LINTELS.

Before describing how to make the actual window cills, &c., a word or two on how to make the moulds for same will perhaps be very useful.

Moulds.—Fig. 43 shows a view of a mould for making window cills, and it can be made by any average carpenter or joiner. Parts *a* and *b* give the detail of the sides of the mould, which need no further elaboration. Part *c* is the piece which forms the ends of the mould, and it requires two of these to complete the mould. If shorter cills are wanted than 7 ft. 6 in. it is necessary to have sliding divisions as shown in Part *d*, and if short cills, say, for instance, 2 ft. long, are required, it will be easily seen that by using four divisions, as shown at *d*, that three cills can be made at one operation of the mould.

Part *e* shows the detail of the cramps for holding the mould together, and three of these should be used to the one mould, as this will prevent the mould from ramming out or bulging. These should be made in wrought iron.

For making window or door lintels it is necessary to substitute Part *f*, Fig. 44, in the place of Part *a*, and Part *g* will then be required for the ends instead of *c*, and the divisions for the making of short lintels are shown in Part *h*. The same cramps can be utilised for heads as are used for cills.

For making plain doorsteps the sides of the mould are the same as for making heads, with different ends and divisions, which are shown in *i* and *j*. It will be noticed that these allow for the making of doorsteps 3 in. thick, but the ends and divisions can be increased or decreased, as the case may be, according to the requirements. This will allow for either thicker or thinner steps as wanted. It will be noticed that Part *b* has a half-round piece of iron screwed to it when making cills. This forms the throating on the under side of the cills. It requires removing for making lintels or steps. The surface of the mould should be treated with two or three coats of French polish or with shellac dissolved in methylated spirits. The top edges should be lined up with $\frac{1}{8}$-in. iron plates, so as to protect them from the rammer and keep them from chipping.

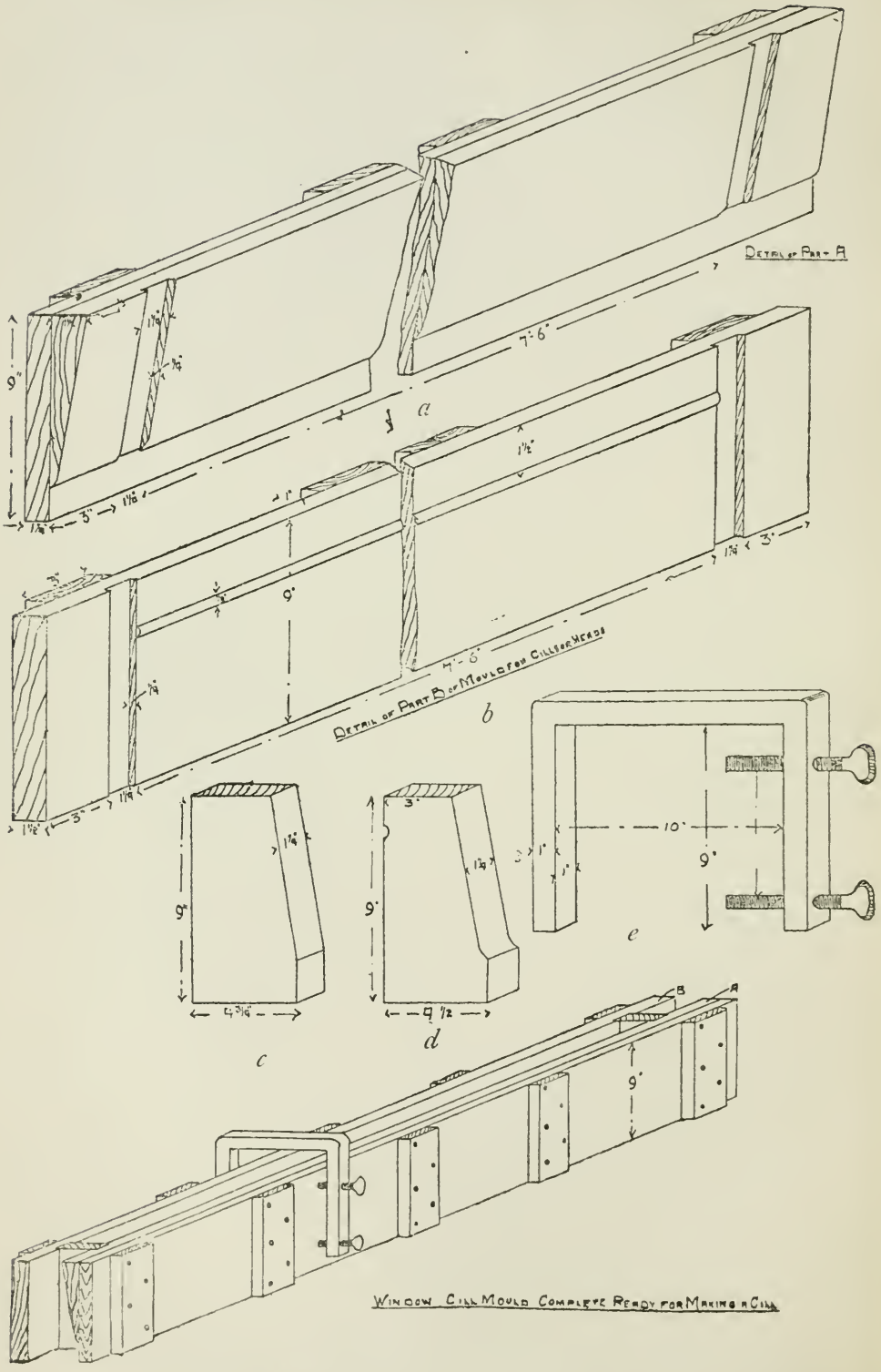

Fig. 43.—The Making of Window Cills, Doorsteps, Headstones, &c.

The mould should be kept quite clean, and should be occasionally rubbed with an oily rag.

How to make the Cills, &c.—All window cills, window and door heads, doorsteps, and rough lintels for the inside heads of doors, windows, and also for chimney openings, should be reinforced with iron rods or bars. The size of the bars depends upon the distance between the supports. For reinforcement, where the distance

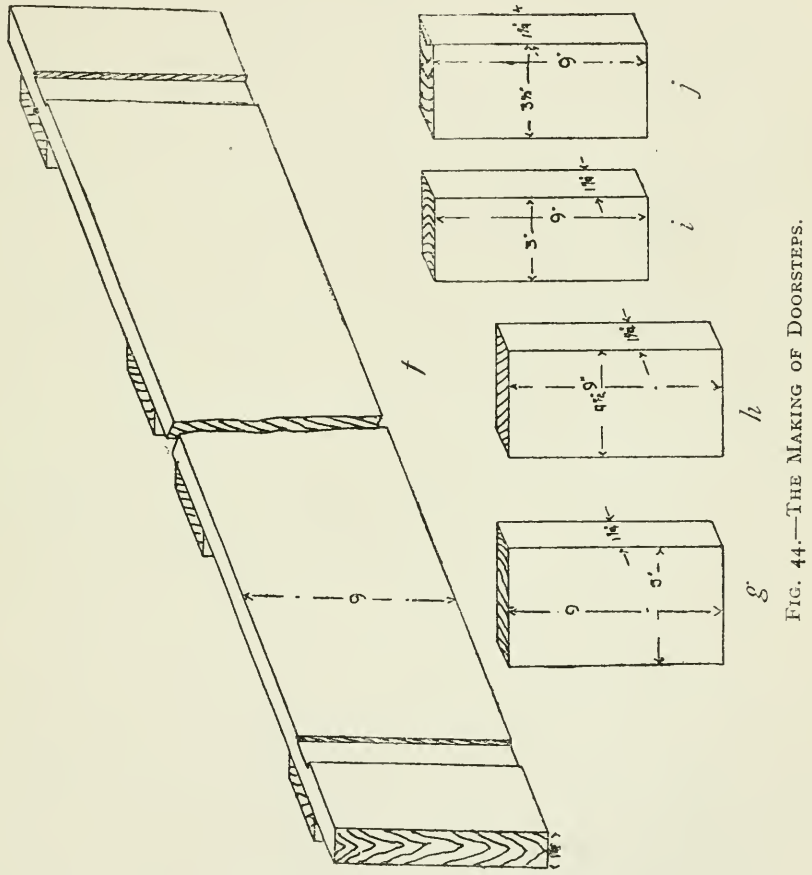

FIG. 44.—THE MAKING OF DOORSTEPS.

between the supports is not more than 4 ft. 6 in., two ½-in. diameter rods are large enough, but the lintel must have at least 6 in. of bearing each end, and, in most cases, where the heads are used with concrete blocks, 9 in. of bearing is given each end. If the opening is larger than 4 ft. 6 in. larger reinforcements will be required. If straight rods are used, the ends will require turning to prevent them drawing out of the concrete. The size of the lintel or head used for cavity block wall is 9 in. by 4½ in., usually, as this size works in with the blocks. A section is given of a lintel showing the position of the reinforcing, which is placed so as to

obtain the best abvantage from it. Cills and doorsteps, which are generally bedded on the walls or upon blocks or brickwork only need reinforcing so that they can be handled with greater ease, and there is thus less liability to breakage.

An illustration is given of sections of window cills, doorsteps, and steps which are suitable for a staircase or any other purpose of the same kind. (See Fig. 46).

The manufacture of window cills and heads is much on the same principle as making hand tamped blocks, but the aggregates require to be graded somewhat differently.

In many cases good clean shingle or breeze is used for the inside mixture of cills or heads, and this is gauged three of $\frac{1}{2}$-in. to $\frac{1}{8}$-in. breeze or shingle to one of washed sand, and one of cement. These mixtures are only wetted to a semi-dry consistency, as mentioned for making blocks, and the facing is put around the sides and face of the mould ; the coarser mixture is filled in upon it, and all

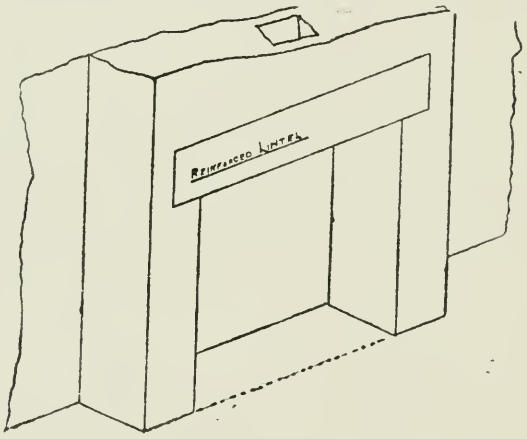

Fig. 45.—Showing Lintel to Fireplace.

tamped down together. Before putting any more material into the mould the surface of the concrete must be scratched so as to ensure one layer adhering to the other. The reinforcing iron should be given a coat of cement wash before inserting in the concrete. This gives a key between the iron or steel rods and the concrete.

Doorsteps can be made in two ways, *i.e.*, upon a floor with the face or wearing surface upwards, or with the face down, which means turning the mould over after finishing the step, and leaving the face upwards to dry off. But the most common way is the " face up " method, as a harder and more dense surface can be obtained. It is well to give steps a coat of cement wash all over after they have been made a week or ten days. If the " face up " method is adopted, after striking the material off level with the top of the mould, a little water can be applied to the surface, and the face then finished off with a plasterer's trowel.

This gives the wearing face a good hard surface. The aggregates for doorsteps and the like are gauged with one and a half of fine granite chippings, one of washed sand to one of cement. This is for the facing, which should be $\frac{1}{2}$ in. to $\frac{3}{4}$ in. in thickness. The coarser material for the inside should be composed of two and a half shingle from $\frac{1}{2}$ in. to $\frac{1}{8}$-in. to one of washed sand and one of cement. In all cases the mixtures are only wetted sufficiently to compose a semi-dry mixture as before described in connection with blocks. After heads, lintels, cills, or door-

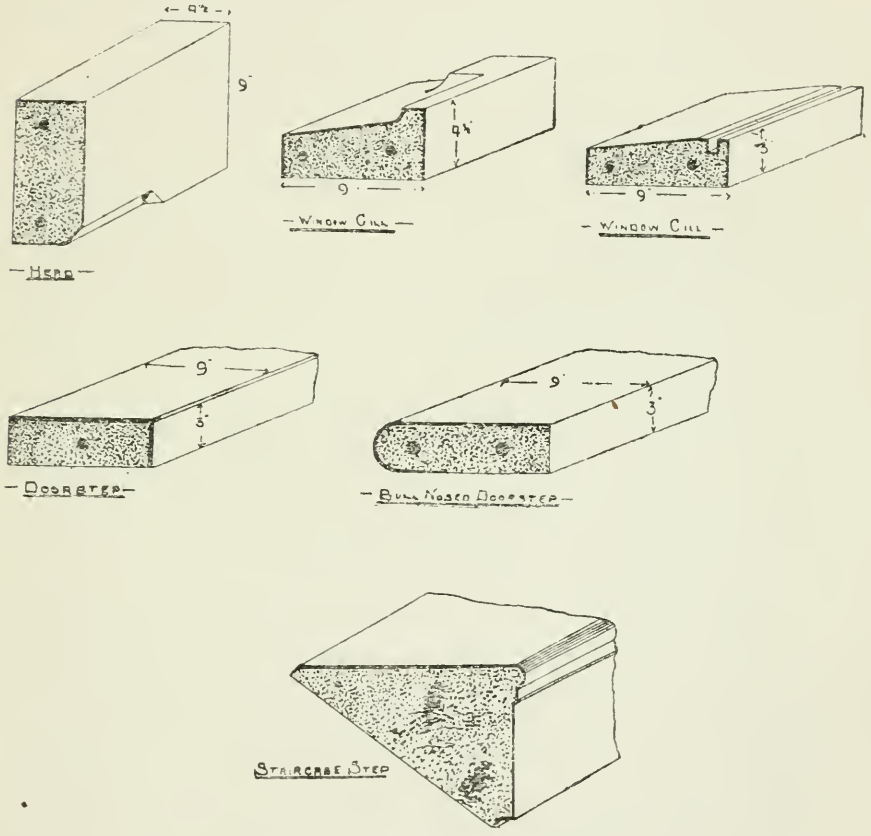

Fig. 46.—Cills and Doorsteps.

steps have been made 24 hours, a sprinkling of water must be applied, and this watering must be continued for each day for six or eight days. It is always well to remember that water is cheaper than cement. By this is meant that, if an article were made with three of aggregate to one of cement and left to dry without any water being applied to it after being made and during the hardening process, it would be found that if the same article were made on exactly the same principle but gauged six of aggregate to one of cement, and after it had been made 24

hours water was sprinkled upon it for six days ; after two months the six to one article would be stronger than the one gauged three to one. Hence, water is cheaper than cement. It is always a good plan to give the articles a good watering after putting into stacks, as this gives them a further chance of gradually hardening off.

Concrete Copings.—Concrete copings for parapet walls may be cast in a similar manner, but with a throating on both edges and a splayed top to throw off the water.

Section VII.

JOINERY AND FITTINGS GENERALLY.

The joinery and fittings generally should be kept as simple as possible for cottage work, and all elaborate mouldings should be avoided. The latter will only harbour dirt and dust and, furthermore, will not look as pleasing as plain chamfers or rounded edges. Doors should be kept at a uniform width and height based upon some multiple of a block, when blocks are used in construction, or in accordance with some standard stock size when blocks are not employed. The windows should be standardised into one, two, or three sizes according to the circumstances, and they also should be in conformity with the block work when this occurs. The area of the window should be based on the floor area of the rooms, the rule being that the total area of the window or windows clear of the frames shall be equal to one-tenth the area of the floor in the room. At least half of each window should be arranged to open, but it is preferable to make the whole available. All window and door frames should be built into the walls as the latter are constructed, as this will make the strongest job.

In the case of plastering only a skimming coat will be required on concrete walls and ceilings in the principal rooms, while in sculleries and similar places no plastering at all will be required and distemper can be applied direct to the concrete.

It is better to avoid any sharp awkward angles when space is at all limited by the use of special splayed blocks which can be readily cast when the other blocks are made.

Pipes should, preferably, be kept on the surface of the walls and when these will prove unsightly they may be enclosed with plain wood casing fixed with screws for easy removal. When butts are provided for the storage of rainwater they should stand on plain concrete blocks to raise them above the ground level, as this will render them less liable to decay.

A small paved area is always advisable at the rear of a cottage and this can be economically provided by a layer of concrete 4 in. thick finished with a coating of cement and sand.

All ironmongery to doors and windows should be made with iron finished black, as this will be cheap and lasting, whereas brass work, quickly losing its lacquer, becomes unsightly unless it is of an expensive character.

SECTION VIII.

LABOUR SAVING DEVICES.

The question of labour saving is of great importance, as the whole of the work in the cottage will usually be done by one person, and if the work can be in any way minimised it will materially assist in making the design successful. Apart from the general convenience that should be aimed at in the planning, to save unnecessary walking to and fro when the cooking and cleaning are to be done, there are many other items which will result in saving labour.

Mouldings should be eliminated wherever possible, and intricate forms with beads and re-entering angles are particularly undesirable, as they harbour dirt and are difficult to clean even when this is attempted.

Skirtings should be avoided unless absolutely necessary to form a finish between the wall and the floor, and then they should consist of a plain board with a splayed top edge. A much better method is that of forming a rounded angle sufficiently large to allow easy cleaning, and this can be simply effected when the floor finish is of granolithic, as it can be run with a curved float when the surface is being laid. An excellent method is that of forming all internal angles in this way between floor, walls and ceiling, as sharp angles always constitute harbourage for dirt.

In the case of windows the soffite and jambs can be plastered to give a clean surface joining up to the main wall surface without the introduction of architraves, and the usual window board can be dispensed with and red quarry tiles substituted, these being easily cleaned by the use of a damp cloth and will not become marked by articles stood thereon, nor will they require painting periodically.

Cupboards should be built in wherever practicable, and these should be formed in a recess to finish flush with the face of the wall and in no case should they project unless they are carried right up to the ceiling, or the flat top will entail so much labour in cleaning.

Where no bath is provided upstairs a draw-off tap for water is very convenient for supplying the bed-rooms, and it will save carrying from the scullery and up the staircase. A small lead tray with outlet to discharge outside the wall will carry away any dripping that may occur.

When a bath is installed upstairs the hot water tank should be placed at the bottom of a cupboard fitted with open shelves for the use of linen, as this will keep the latter aired and ready for use. If the flow pipe supplying hot water to the bath is kept a few inches from the wall this can be used as a towel rail, and it will be helpful in drying. The cold water cistern should be easy of access, as should also the stopcock controlling the supply.

A gas cooking stove and also gas fires will save considerable labour when they can be adopted, and if a gas-heated copper is used this will prove a great saving and it can be utilised for heating the water for the bath, thus dispensing with a range which always entails the use of a large amount of fuel in addition to much work.

When a gas cooking stove is provided, a few white glazed tiles on any wall surface which is adjoining will prove of great benefit, as without these the wall surface becomes blackened and badly marked by grease splashes.

Washing up—always a bugbear to the housewife—will be simplified by the addition of a plate rack fixed over the sink in a convenient position to drain down into the latter.

A mat sinking in the floor at the entrance will ensure dirt being wiped off the boots when entering, and prevent the mat being moved about with the consequent scattering of dust.

A concrete shelf faced with cement and sand in the bottom portion of the larder is very useful for milk and similar articles which have to be kept cool, and such shelf is easily kept clean.

There are two other items which save a great deal of labour, but the cost will unfortunately often render them impossible. The first is a lavatory basin in the bath-room, and the second consists of two deep glazed sinks which are fixed with a small wringer between in the scullery or wash-house. The articles can then be washed in one sink, and passed through the wringer into the other sink for rinsing, and all splashing of water on the floor is avoided.

This method will be found particularly valuable in saving time and labour where all the washing is done by the housewife, if the money can be allocated for its installation.

CHAPTER II.

THE CONSTRUCTION OF OTHER SMALL BUILDINGS.

Section I.

INTRODUCTION.

Concrete can be profitably employed in the erection of many types of small structures apart from actual cottages, and it is proposed to deal with a few of these buildings and show in what manner the material can be utilised, while at the same time giving some general notes as to the planning and arrangements of the buildings, which should prove useful to the reader apart from any question of material employed.

The use of concrete for farm purposes is invaluable, and it has been extensively employed, the material being made by such labour as is available under the supervision of an experienced man, and excellent results have been obtained.

As an example of the buildings in which concrete can be successfully used, mention may be made of (1) small garages, (2) cow sheds, (3) stables, (4) barns, (5) piggeries, (6) dairies, (7) greenhouses, and (8) root cellars. It can also be adopted for septic tanks, water wells and such-like purposes, and it will be found more durable than any other material while proving economical in first cost.

SMALL CONCRETE GARAGES.

Introduction.

There are many points to consider in the design and construction of small motor garages, and this type of building is probably the most important of any of the outbuildings erected in connection with ordinary domestic usage, on account of the value of the contents stored therein. In spite of the latter fact, however, it will often be found that an expensive car is housed in a cheap and unsuitable building, and in many cases this is due to the lack of foresight and experience on the part of the owner rather than to any deliberate attempt to save a few pounds to the detriment of the building itself. If the obvious advantage of a suitable structure, which need not necessarily be expensive, were clearly set down before the average motor car owner, it is quite certain that he would not be prepared to run the risks of a combustible or temporary building, and the result would be that garages would be built on better lines.

The chief points to consider in connection with every garage may be stated as follows : (1) Site ; (2) dimensions ; (3) materials of construction and finishing ; (4) storage of petrol ; (5) lighting and heating ; (6) ventilation.

Site.

The first point will naturally be much governed by the circumstances which obtain in each particular case, and it is quite unlikely that identical conditions will be met with in any two cases.

There are, however, some considerations which should be borne in mind when planning the position of the structure, such as the accessibility from the road, the space for turning the car, the space for outside washing, and the distance from the water, gas and electric light mains. The garage should also, preferably, be kept away from the dwelling-house, even when the regulations of the district do not insist on such a condition, and it is also a very bad policy to house the car in any garage which is adjoining wooden sheds or other combustible erections.

Dimensions.

With regard to the dimensions, it may be sufficient to provide for a particular car which it has been definitely decided to house ; but if this is a small car it may not prove economical to build the garage to suit this only, as in the event of the owner acquiring a slightly larger car, the building may be useless. It is a wise policy to make the garage of such dimensions that it will accommodate any ordinary size car, and thus a standard type can easily be evolved. The general tendency is to make the garage so small that there is a difficulty in passing the car, and all inside repairs are impossible. To allow a clearance on each side of about 2 ft. necessitates a width of 10 ft. to 12 ft., and the latter dimension is often adopted. The length will be influenced by the question as to whether an engineer's bench is to be provided at one end. If this is required it should be about 2 ft. wide, and there should be 3 ft. for working at the end of the car, necessitating a total length of about 21 ft. in the garage. If no bench is to be installed, then the length may be reduced to 18 ft. or even 16 ft. For a small car, where the cost is to be reduced to the minimum, the size can be taken as 10 ft. by 16 ft., and for a moderate size car, with a bench, the dimensions should be 12 ft. by 21 ft.

Material of Construction.

The selection of the materials used in the construction and finishing of a motor garage is one of great importance, and too much care and consideration cannot be exercised in this direction. The primary points to be kept in view are —(1) fire resistance ; (2) durability ; (3) appearance ; (4) economy. The materials in common use are concrete, bricks, stone, timber and galvanised iron, and some of these are very unsuitable ; while there is no doubt that concrete takes first place as a good material which meets all the conditions imposed under the four primary points as stated above. Concrete has the valuable characteristic that it can be used for the floor, walls and roof, and thus it is the one material that will provide a homogeneous structure. If brick or stone is used, then the floor and roof will require to be of some other material ; and although satisfactory buildings are erected with these materials, they do not combine the maximum of fire resistance with economy and durability, and thus concrete is

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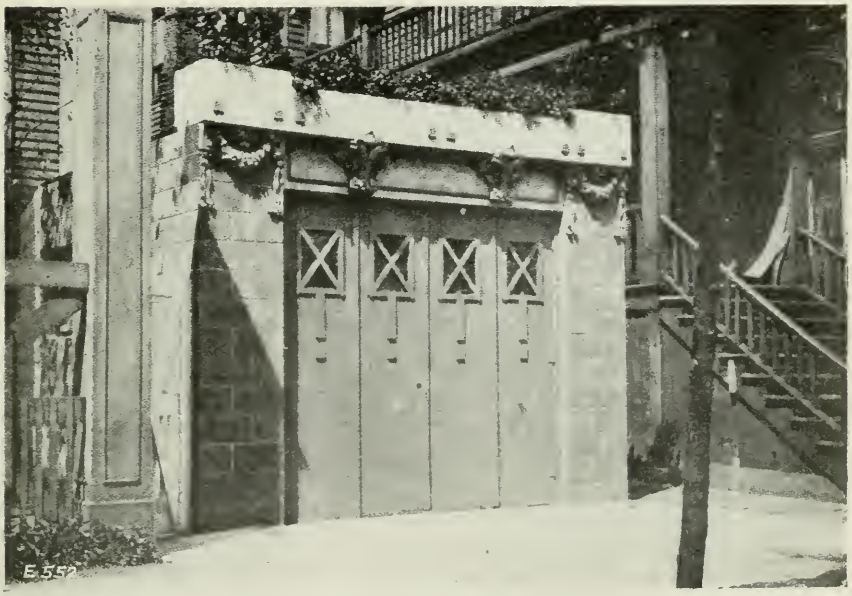

FIGS. 47 AND 48.—CONCRETE BLOCK GARAGES.

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FIG. 49.—A GARAGE WITH LIVING QUARTERS ABOVE.

FIG. 50.—A GARAGE PARTIALLY BUILT OF CONCRETE.

daily becoming more universal for garage construction. Concrete is eminently fire-resisting, as has been proved by actual fires in buildings. It is the most durable material in existence ; a very pleasing appearance can be obtained, and it is more economical as regards initial outlay than either brick or stone. The material has been successfully used in numerous garages, and some of these are here illustrated, where the satisfactory appearance can be seen.

Floor.

The floor should be constructed with 5 in. or 6 in. or plain concrete, laid to fall slightly from the two side walls to the centre, where a channel for drainage is formed ; but the floor should be level across the longitudinal section. This concrete should be composed of 4 parts suitable aggregate, 2 parts clean sharp sand and 1 part of Portland cement. In the majority of cases no hard core is necessary under this concrete, which can be laid directly on to the ground when the top spit has been removed. The channel formed in the centre of the floor should be carried the full length of the building and discharge into an open gulley outside. The surface of the concrete should be finished with a non-absorbent material, to prevent oil soaking in, as the latter is very destructive to the tyres, and good materials for this purpose are granolithic, composed of granite chippings and cement, or cement and well washed sand.

When the ground is suitable it is an economical method to carry the concrete forming the floor over the site to the outside line of the walls in the nature of a raft, and upon this the walls are built direct. This will obviate any trenches for the wall foundations, and thus both digging and material are saved. It may be considered by some that it is absolutely essential to carry the wall foundations down to a point below the level of atmospheric influence, to avoid settlement ; but in small light buildings, such as are here dealt with, it is rarely necessary, and the writer has constructed many buildings on the economical principle above mentioned without having a single failure. If the ground is very poor and unreliable it will be necessary to increase the thickness of the concrete under the walls accordingly, and the bottom of the building will then be in the nature of a large slab with plain concrete beams projecting on the underside, and it is advisable to lay the whole of the concrete as one process and form the floor and foundations as a complete unit.

Walls.

With regard to the walls, there are various methods of concrete construction each of which has its particular advantages according to the circumstances of the case. It must be borne in mind that the walls do not need to be carried up to a great height, 8 ft. 6 in. or 9 ft. being sufficient in all cases, and therefore a heavy type of construction is not essential. The concrete may be used either in the form of blocks, or to give a monolithic structure by being cast between vertical shuttering, or, again, the garage may be built with light steel uprights covered with metal lathing to serve as a ground for stucco or cement plaster.

Some idea of the pleasing effect that can be obtained by the use of the

concrete blocks is seen in Fig. 51, which is a photograph of a garage built for one car. The design is very effective as regards appearance, and although the dormer window in the roof could be omitted, and the doors and windows simplified to reduce the cost, it affords a good example of concrete block walling. The drawings for a simple garage with alternate elevations for monolithic or block construction are illustrated in Fig. 57, and the general arrangement of a cheap structure for one car is shown. Other examples of the application of block construction are given in Figs. 47 and 48. The first of these two illustrations is interesting as showing the effect of using blocks of varying sizes. Although not commonly adopted, this method should remove the prejudice that exists in the opinions of many persons that concrete block construction is monotonous on account of the units being uniform in size and colour. The second illustration indicates some originality on the part of the designer, and shows the possibility of concrete work.

Concrete Blocks.—In the case of block construction for the walls, it will be realised that the conditions which have to be met in domestic buildings will not be applicable to garages, and the arbitrary by-laws which exist in many districts for cottage work will not be enforced in the case of structures which are not built for habitation. The use of ordinary hollow blocks will give a thickness of wall of 9 in., and this will be satisfactory for all ordinary cases without any outside rendering or rough cast, and no plaster will be required on the inside. If the building is at all exposed to adverse weather conditions the blocks should be made with a face consisting of 2 parts of sand and 1 part of Portland cement, as this will render them more impervious to rain. The face may be moulded with a rustication or left plain, as may be desired, or rock-faced blocks may be used for the quoins only, but care should be taken to keep the work simple and not too heavy in such small buildings. The remarks given in connection with block construction for cottage walls will generally apply to garage work.

Monolithic Walls.—When the walls are constructed with monolithic concrete the thickness usually employed is 5 in. or 6 in., and a little reinforcement is added in the nature of small rods spaced at 18 in. or 2 ft. centres to prevent cracks. These rods should be carried down into the concrete at the bottom and into the roof at the top when the latter is of concrete, and additional steel is provided over the openings and at the corners. The drawings of the slightly larger garage than that usually employed for one car is illustrated in Fig. 56, where monolithic construction is indicated. The walls are here given as 8 in. thick reinforced with $\frac{3}{8}$-in. diameter rods at 2 ft. centres, and the corners are stiffened by piers 3 ft. wide on face and 12 in. thick. This construction would be quite effective, but it would prove more expensive than the use of concrete blocks, and the outside surface of the walls would require some form of treatment, either rendering or rough cast, to produce a pleasing appearance. Another suggestion for a monolithic structure is given in Fig. 58, where the most simple type possible is illustrated. A building of this kind is practically a concrete box, and apart from its appearance it is cheap and eminently suitable for housing a small car where fire resistance is desired, and the maintenance is practically

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FIG. 51.—A ONE-CAR GARAGE OF CONCRETE BLOCKS.

FIG. 52.—A GARAGE WITH CONCRETE WALLS.

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FIG. 53.—METAL LATHING FRAMEWORK FOR SMALL GARAGE.

FIG. 54.—VIEW OF METAL LATH STRUCTURE COMPLETED.

nil. The walls are given as 6 in. thick, reinforced with $\frac{3}{8}$-in. diameter rods at 2 ft. centres, and three $\frac{1}{2}$-in. diameter rods over the entrance doors. Although small monolithic structures have been built with some success, they will not usually be found so economical as those built with separate units, because the shuttering is expensive, especially with timber at its present high price, and a certain amount of skilled labour is necessary in its erection, and it is only when the shuttering can be repeatedly used in repetition work that the outlay will be refunded to the builder. Garage work does not usually provide much scope for such repetition work, and thus the use of concrete blocks is likely to prove more economical and be more generally adopted than the monolithic type. The cheapest possible from of construction for small buildings, which are to be weather-proof and lasting, is provided by the use of well-made, seasoned concrete blocks, and it has a great future before it if its reputation is not damaged by careless work.

Metal Lathing with Stucco, etc.—Mention was made in the earlier notes of walls constructed with metal lathing and covered with stucco or cement plaster and an excellent example of this class of work is illustrated in Figs. 53 and 54, where two photographs are given, one showing the framework and lathing as fixed in position and the other giving the finished building. The appearance of the structure certainly leaves much to be desired, but it is a cheap and efficient covering for a car, and far preferable to the wooden and temporary buildings that are so often seen. In some cases this type of building is erected with small reinforced concrete columns at the corners with wires passing through the concrete for the attachment of the metal lathing which is used for the filling. Wherever metal lathing is adopted the vertical members to which it is attached should be well secured at the foot to the floor concrete or concrete foundations in order to provide efficient anchorage.

Roofing.

The roof will naturally be one of two types, viz., flat or pitched, and each will be found to possess certain recommendations, as compared with the other. The notes given in connection with cottage roofs deal with the respective merits of the two types, and the construction of flat roofs is described.

Pitched Roof.—A few additional notes are necessary in the case of pitched roofs from the point of view of fire-resistance. A suggestion for a fire-resisting roof is given in Fig. 55. The hips are formed with $1\frac{1}{2}$-in. gas barrel bolted to a 3-in. by $\frac{1}{2}$-in. steel ring 8 in. in diameter at the apex and connected to the concrete at the foot by means of a $\frac{3}{4}$-in. diameter rod which is embedded in the concrete wall for a distance of 2 ft. and bent over to pass inside the gas barrel for a distance of 12 in. The vertical rods throughout the walls are bent over and extended up the roof slope for a length of 18 in., and the metal lathing is fastened to these and the gas barrel at the hips. The roof is finished off with 2 in. of good, fine concrete above the lathing and 1 in. of plaster below. This method provides a simple inexpensive form of roof covering, and is quite suitable in the case of small concrete garages.

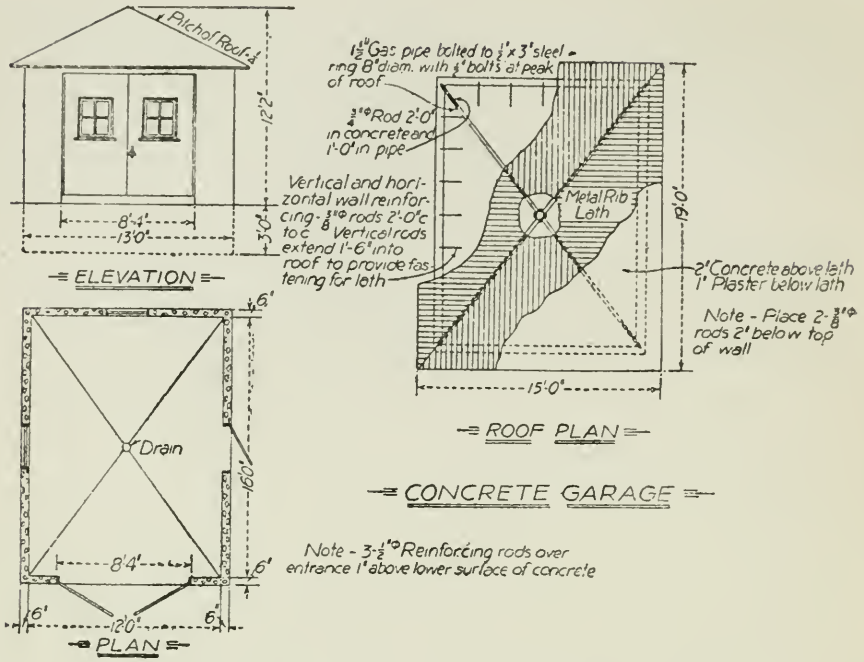

FIG. 55.—DESIGN FOR A GARAGE TO BE CONSTRUCTED OF MONOLITHIC WALLS AND ROOF CONSTRUCTION OF METAL LATH WITH CONCRETE ABOVE AND CEMENT PLASTER BELOW.

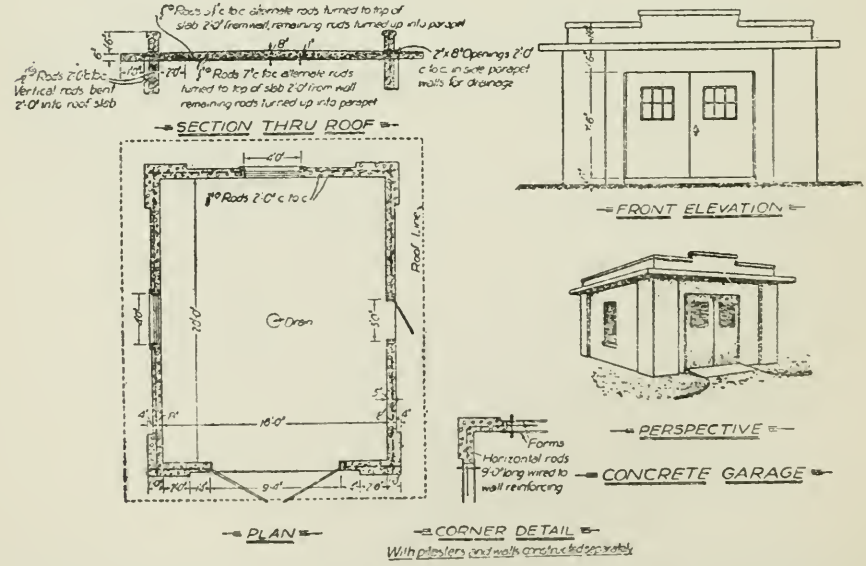

FIG. 56.—A PLAN FOR A GARAGE OF MONOLITHIC CONSTRUCTION WITH PILASTER EFFECT AT CORNERS.

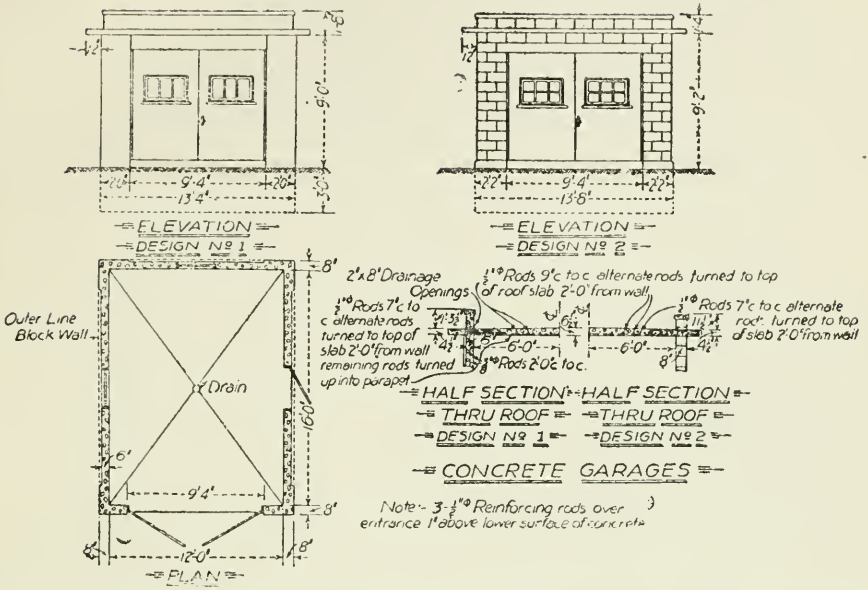

FIG. 57.—DESIGN FOR A SMALL MONOLITHIC CONCRETE GARAGE SHOWING ALTERNATIVE CONSTRUCTION IF CONCRETE BLOCKS ARE USED.

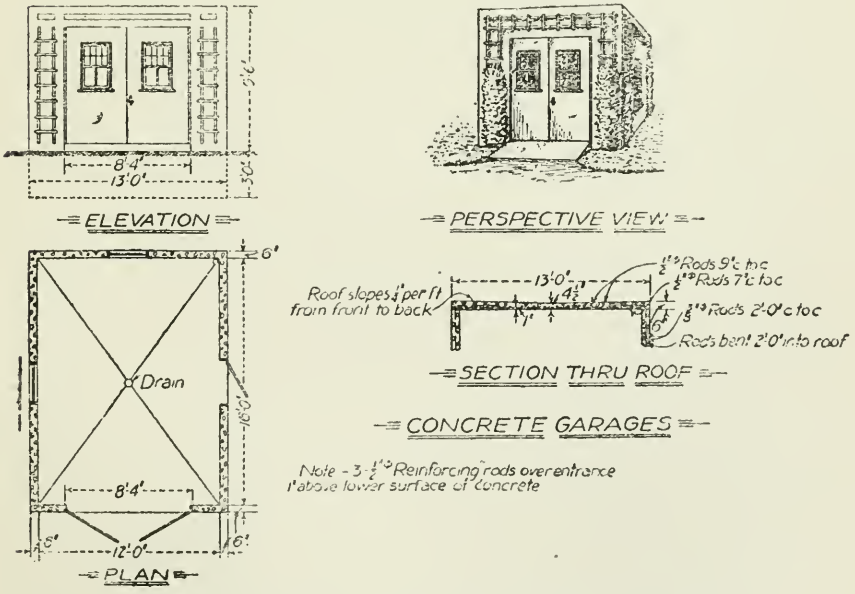

FIG. 58.—A DESIGN FOR A SIMPLE STRAIGHT-LINED GARAGE.

When timber is used in a pitched roof this should be of the simple collar type, with 4-in. by 2-in. rafters at 12-in. spacing, and with 4-in. by 2-in. collars placed about one-third the length of the rafters from the springing. The feet of the rafters should be spiked to a 4½-in. by 3-in. wall-plate bedded on the inner edge of the walls. To overcome the great risk of fire that is present with a timber roof, it is advisable to protect this as far as possible on the underside, although additional expense will, of course, be incurred. A very good method is that of lining the soffites of the sloping and flat portions with asbestos sheets attached to the underside of the rafters and collars, using as few joints as possible, As these sheets are obtainable in 8-ft. lengths, there need only be one set of transverse joints in a garage 16 ft. long.

Another method is to cover the underside of the timber with expanded metal lathing, and apply 1 in. of plaster to form a ceiling. This will afford a certain amount of protection against fire, but it cannot be compared for fire-resistance with a flat concrete roof. The outer covering of a pitched roof may be executed with slates, tiles, or concrete roofing-tiles. The latter make an excellent material for a small concrete building, as they are comparatively cheap, lighter than clay tiles, and when of the interlocking type it forms a safer roofing than any other covering, as the strongest wind will not lift the tiles or make a hole in the roof. Most readers are familiar with the thin slates made with Portland cement and asbestos fibre as these are much used in buildings of all sizes. They give excellent results, and may be successfully used in motor-garage roofs as they are cheap and effective.

Windows and Doors.

To maintain a suitable fire-resisting garage throughout, the windows should be formed with metal sashes and preferably glazed with wired glass. Wrought-iron sashes will be found to resist fire better than cast-iron, and they are generally more reliable as regards strength and shape. If wood sashes are employed they should be of hard wood such as oak or teak if they are to be fire-resisting.

The doors and frames should also be of hard wood when the expense can be incurred, as it must be remembered that it is essential to prevent the car being damaged by fire from outside where adjacent buildings are of a combustible nature.

This is a point, however, that it is seldom necessary to enforce, as a clear space must be provided in front of every garage for the ingress and egress of the car, and it is rather unlikely that the main entrance doors will be subjected to any fire other than that which may occur on the inside, and in the latter case they would be opened for the purpose of attacking the fire. The doors should not exceed 9 ft. in width or they will become unwieldy and liable to drop on the hinges. A clear width of 8 ft. 6 in. will always be sufficient for the average size car to enter, and thus each leaf will be 4 ft. 3 in. wide. The windows should not be placed too high in the walls, as a good light will be required near the floor level for the examination and repair of the car. The light should be distributed as far as possible around the building so that all sides of the car will be readily seen.

Various types of doors and windows are shown in Figs. 49, 50 and 52 which illustrate different garages that have been built with concrete walls.

In the case of the building given in Fig. 49 it will be noticed that living accommodation is provided over the garage, and in such a case as this it is absolutely necessary to provide the maximum amount of fire-resistance for the sake of the occupants. This can only be done if the garage and living-rooms are separated by a concrete floor and all combustible material is omitted in the construction of the garage.

The Storage of Petrol.

Petrol should never, under any circumstances, be stored in a motor-house. It should always be kept away from the building and stored in a separate portable iron cupboard or small building, and arrangements should be made for efficient ventilation. If a pipe is taken to the garage with a pump for the purpose of filling the tank it should not be carried inside the building, but the filling should be done outside.

Lighting and Heating.

Electric light is undoubtedly the best method of artificial lighting, and this should be executed with screwed conduit and all the work done in the best possible manner. Naked lights of all kinds should be avoided, as petrol is inflammable and its fumes highly explosive. A plug to which a movable hand-lamp can be attached will prove very useful in the examination of the car, and especially in the case of work executed in the pit. If the garage has to be entered at times when artificial light is necessary an electric hand-torch may be used if permanent electric lighting is not available, and if any other kind of light is used it is advisable to open the doors and windows for a short period to allow any accumulation of fumes to escape before the light is used.

For the heating, electricity, hot water, or steam are the best, and an open fire, whether of coal or gas, must not be used. In some cases hot-water pipes can be extended from an existing apparatus attached to a greenhouse or conservatory and where such is not possible the fire for heating the pipes must be kept outside the garage. Injudicious heating has been the cause of many garage fires, and it, will not prove economical to keep down the cost of the installation if the car and building are to be endangered.

Ventilation.

The ventilation is a very important point and the general arrangement should be such that a continuous and free passage of air is given. The vapour thrown off by petrol is heavier than the surrounding atmosphere and consequently it drops to the floor level. A sufficient number of ventilators should, therefore, be provided at a low level, and these should be capable of being closed if required during very frosty weather. Ventilation at a high level should also be provided to carry off smoke caused by over-lubrication of the car. Opening skylights are sometimes adopted for this purpose, but there is great difficulty in keeping these watertight, and they are not to be recommended in a garage. If gables are provided at each end a small opening sash in these will induce sufficient draught to carry off the

smoke and obviate the difficulty caused by skylights. Another method is to provide a 4-in. flexible tube communicating with the outer air, which tube can be coupled to the exhaust pipe when necessary.

Inspection Pit.

The question of providing a pit for inspection and repairs is one upon which there is some difference of opinion amongst motor-car owners. If extensive repairs are contemplated a pit is a necessity, but a small garage is often better without one, as water is liable to find its way into the pit and dampness will result. If the adjoining drains are sufficiently low a gully can be provided in the bottom of the chamber and this disadvantage overcome to some extent. If the pit is placed outside the garage, however, as is sometimes done, it is a great detriment

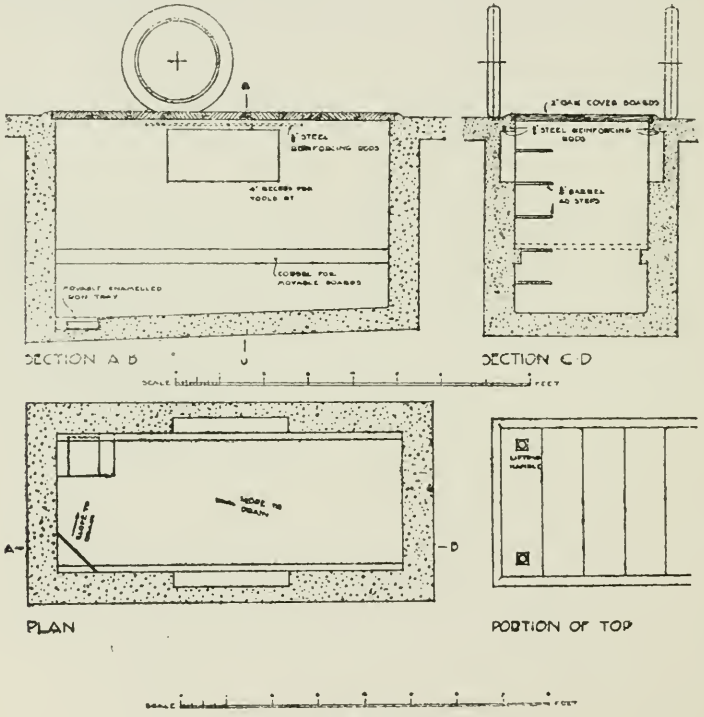

FIG. 59.—MOTOR PIT.

to the car to stand unprotected for some considerable period while repairs are being executed.

When a pit is provided the most satisfactory material for its construction will be concrete. The size should be 6 ft. long by 3 ft. wide and 4 ft. 6 in. deep, with projecting ledges on each side to take movable boards 3 ft. 6 in. down from the top. The walls should be of 9 in. concrete, and the bottom 6 in. thick, recesses being formed at a convenient level in each side wall to hold tools and small parts. A rebate should be formed at the top of the concrete walls to take a cover flush with the floor level, this being formed with 2-in. boards

fitted with sunk lifting handles. If a gully is provided in the bottom the floor should be made to fall towards same. When a pit is provided inside the garage it will be necessary to do any washing to the car outside, and, in fact, the washing is better if done outside as it prevents a lot of dirt and water inside the building. A small concrete-paved area should be formed in front of the building with a gully in the centre, and this will form a convenient washing space.

Drains carrying petrol should not be connected directly to the sewer owing to the danger of gas accumulating in the sewer and causing explosion. To overcome this difficulty the effluent from the garage should be taken through a special set of three chambers which are each ventilated above the water level. The drainage inlet in each chamber is at a high level and the outlet at a low level, and the direct passage of floating oil is prevented. The chambers should be covered with sealed manhole covers, and the walls and bottoms can be constructed economically with plain concrete which is brushed over with Portland cement immediately upon removal of the shuttering.

SECTION II.

COW-HOUSES.

General.

The planning and general design of cow-houses requires to be considered from several points of view, and it is not sufficient to construct a building to hold so many cattle without due regard being paid to the feeding and health of the animals, and the conditions for milking.

In the first case, any cowshed must be designed in accordance with the requirements of the local authority under the Dairies, Cowsheds and Milk Shops Order, and it will be found that the usual minimum space prescribed is 800 cub. ft. per cow in cases where the cows are habitually kept and fed in the building, and 600 cub. ft. when they are turned out for at least part of the day.

If an allowance of 3 ft. 3 in. is made as the minimum width of standing for each cow, the total length of the building can be arrived at for any number of cows. If the animals are standing in a single line only the width required will be 14 or 15 ft., this giving 2 ft. for the feeding trough, 6 ft. standing space, 2 ft. for gutter, and 4 or 5 ft. for the gangway. In addition to this, width must be allowed for a feeding passage when necessary, this being sometimes arranged so that the cows are standing in two lines, head to head, with the passage between the two stalls, and this method is convenient and economical where a large number of animals are to be provided for.

Ventilation.—Adequate ventilation is essential, apart from any question of cubic space, and at the same time dangerous draughts should be avoided. In the case of a pitched roof, louvres or other openings should be provided to prevent the accumulation of stagnant air in the roof space, and the upper part of windows should be hung at the bottom and hinged to open inward with shields at the sides to prevent the air dropping immediately downward.

Lighting.—Good lighting is essential for clean milking, and the clear area of light should not be less than 2 sq. ft. per cow. This is a point that is often not

seriously considered by designers, as the lighting is looked upon as quite a secondary matter.

Planning.—It is generally advisable to plan a cowshed so that future extensions can be economically made, because there is always a possibility of the stock being increased, and if new sheds necessitate entirely new buildings without the convenient use of existing fodder-rooms and the like, it will make a great difference in the cost.

In farm buildings it will often be found that the outbuildings and sheds necessitate a larger initial outlay than the farmhouse itself, and thus there should be more scope for economy in construction, while convenience in the general

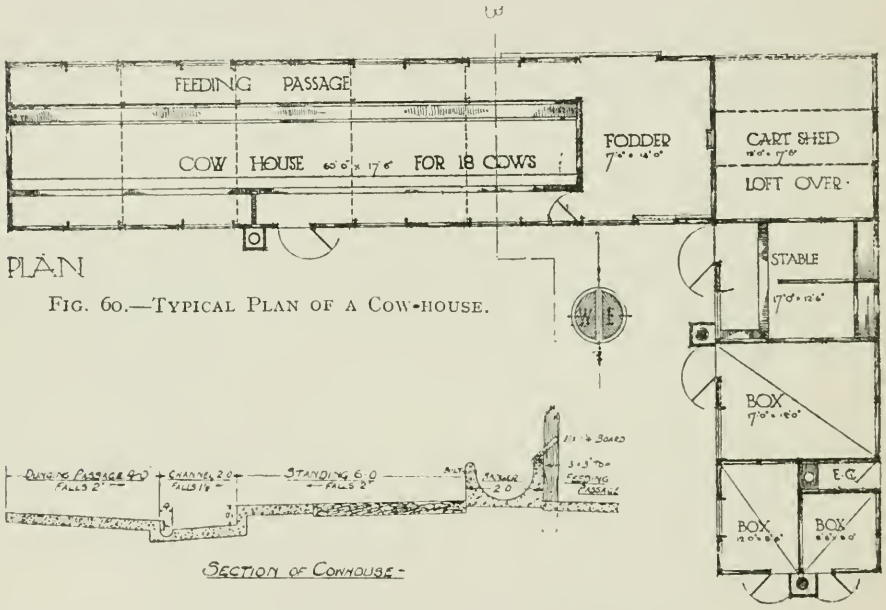

FIG. 60.—TYPICAL PLAN OF A COW-HOUSE.

FIG. 61.—FLOOR SECTION FOR COW-HOUSE.

arrangements will naturally assist in the management and execution of the farm work. A plan of a typical cow-house is given in Fig. 60.

Construction.

Walls.—Timber has been greatly used in the construction of cow-houses in the past, and is still used to some extent, but such a practice is not to be recommended, as the only merit it possesses is that of comparatively low initial cost. It may be quite suitable for roof work, but it is certainly not the ideal material for the walls, although it can often be seen in the latter as the constructive material. Vertical wooden posts are employed, these being let into a low concrete wall which forms a base, and small horizontal rails are framed between the posts, the whole being covered with 1-in. vertical boarding or weather-

boarding. Such a method of construction is after all but of a very temporary character. It requires constant repair, will prove a serious menace in case of fire, and cannot be considered hygienic, as it is difficult to keep clean and vermin are encouraged.

Concrete as a material for the walls possesses none of these disadvantages, and although slightly more expensive than timber in the first instance, it will prove economical when considered over a period of years, while it compares favourably with any other material that can be used, such as brickwork, both as regards durability and first cost.

The concrete may be used in the form of blocks or it may be monolithic in character, as described in the previous chapter, and the notes on wall construction as given for cottages will apply generally to cow-houses, with the exception that cavity walls will not be required, and no provision is necessary for plastering or finishing generally.

The most suitable type to employ will be hollow blocks, and they need not be rock faced or made with a special facing mixture as long as they are reasonably well made with correctly proportioned concrete.

In some cases the walls are constructed with concrete blocks $4\frac{1}{2}$ in. thick only, and an example of such work is here illustrated, the buildings having been erected at Wayford Wood, Norfolk.

These buildings (Figs. 68 and 69) comprise a harness room, stable for two horses, a cow byre for four cows, and four pigsties. These buildings have been erected in concrete blocks. The walls are $4\frac{1}{2}$ in. thick. The roofs are of concrete tiles.

A similar type of farm building erected on the same estate shows two cow-stalls, a fodder-room, and two pigsties. In the courtyard there is a trough made entirely of concrete, with a shoot from the outside wall to the trough.

From the fodder-room there is a feeding passage at the head of the cow-stalls. The manger is of reinforced concrete, and the Danish principle of having it low has been adopted. The walls are all built of concrete $4\frac{1}{2}$ in. thick, the size of each block being 18 in. by 9 in. by $4\frac{1}{2}$ in. The roof is of concrete tiles (glazed red). The building is fitted with a concrete tank sunk in the ground, to which all the liquid manure is drained.

Another example of a farm building constructed of concrete, but on the system of forming the walls flat on the ground and afterwards raising them into position, is shown in the following illustration (see Fig. 62).

The plan of this building is that of three sides of a square, two sides being of one storey, while the other, in which are situated the fodder-room, stables, and a loose box, has a granary and loft overhead.

The method adopted consists in moulding the segments of building on platforms, which are temporarily hinged in a way to be described, then rearing the platforms with segments on them to a vertical position, lowering away the platforms for use with other sections, and finally securing the segments together.

The hinges are made of $\frac{3}{4}$-in. bar iron bent into hoops, with the top about 4 in. across and long ends 2 ft. A number of these are placed in a row and blocks

of concrete 1 ft. cub. cast round them. These blocks are simply to keep the hinges upright and in position in the foundation trench while foundation is being built around them. They are just the weight a man can easily handle, and heavy enough to remain where he puts them while he builds up to them or tamps concrete around them.

The platform is laid on light girders, I section, which have hooks attached at one end for hooking on to the top of hinge ; the drop of the hook is set so that the top of the platform, made of boards—say, 1½ in. thick—when laid on girders, comes level with the centre line of top part of hinge. On the plaftorm is moulded the section of building.

It is clear that if the girders with platform are now reared up the section

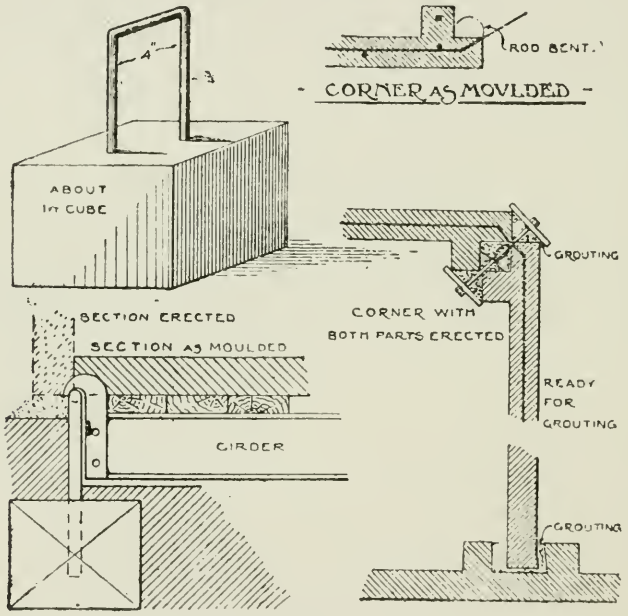

Fig. 62.—Details of Construction for a Farm Building.

of building must come exactly into its proper place, the face next to platform being the outside of building, and if the hinges are set in line the section must be true. It will be noticed that the weight of the section when, say, at an angle of 20 deg. from vertical, is borne by the hooks until it is safely placed on the foundation, when the platform is lowered away and girders unhooked.

In setting out the foundation no time is lost. For a square building four lines are stretched to dimensions of outside of building, the lines being, of course, level and square ; then the hinges are put down at any convenient points along the line and up to level ; no matter where they are along the line, the section when erected must come into its proper place.

In building or concreting the hinges in place a channel is left where the

girders will come. This is easily done by having a temporary piece of wood the required shape to represent the girder while building or concreting, the surface of foundation being purposely left 2 in. or so below the required bed level.

After the section has been moulded and is setting, in order to get the part where it will rest to exactly the proper level, it is only necessary to dump down some concrete and strickle it off from the face of the section, now lying flat, with a notched board the same depth as thickness of section, thus avoiding all levelling with staff and spirit level.

The erection of the segments is done by winches, generally equal in number to the hinges used, a joist being put under all the ends of girders and the ropes attached to that, the men being careful to turn together so that the lift may be uniform. There is a back-pull winch to prevent going beyond vertical. Suppose there are three winches used, as was the case in gable end, when section is vertical two props are placed under the top flange of gable or any projecting part, and the centre winch made fast to a couple of pieces of bent iron cast near the edge for this purpose and also for attaching the sides when they are erected. This winch then pulls against the props and the other two can "lower away"; the platform then comes away and is taken to pieces, the girders are unhooked, and props placed to support the other side. These props bear against the pieces of wood put through holes which are left by the blocks supporting the parts of mould forming the flange, or the holes may be left purposely and pointed up when finishing off the building.

Paper is laid under the concrete so that it will not stick to the mould. This paper can be had in rolls, costs very little, and is easily applied.

The corners of building are jointed and strengthened as follows :—In moulding there is a flange cast at some distance (generally equal to thickness of section) from the edge, and the reinforcing bars are prolonged through for some distance. When cement is set the ends are bent round to circle, and it will be seen that the two sections coming together allow boards to be put on each side of joint, the whole grouted in; thus a strong pillar for corner is made, as well as a tie for the sides.

Party walls are joined to sides by a simple dove-tailed joint grouted in.

The wall-plates are made of coke breeze concrete to enable the rafters to be nailed direct on to the walls—saving timber wall-plates.

When commencing the mould the girders are hooked on to the hinges and their free ends supported on pieces of timber laid direct on the ground; they are then brought up to level in a few minutes by means of folding wedges. The boards are then laid on and the outline of section made with spars that will be used afterwards for the rafters, and pillars are outlined in the same way, the stuff being used again for another section when concrete is a couple of days old.

A doorway is formed by simply laying the door itself flat on the platform in its proper place, with hinges and latch all complete, and casting the concrete around it. Thus no door posts or jambs are needed; thin pieces of wood $\frac{1}{4}$ in. thick are tacked round the door, and these give clearance for the door to open or shut; there is consequently no fitting of any description whatever.

The walls of this building are 3 in. thick with 6-in. pillars, cement and fine gravel 4 : 1, reinforced with ⅜-in. bars spaced 12 in. each way. They can be built at very little more per yard super. than cost of a floor of concrete 3 in. thick. The raising of walls is a very small item. The total size of building walls is 3,668 super. ft. ; floor space is 1,620 super. ft., and cubic contents 22,772 ft., measured inside and to floor level only. The total cost of erection and fitting inside complete is £256 10*s.* 6*d.*, as against £414 for a similar structure which was built of stone, the stone being supplied free.

Further particulars of the system, which has been provisionally protected, can be obtained from H. W. Buddicom, M.I.Mech.E., Penbedw Estate Office, Mold.

Floor Construction.—The formation of the floor in a cowshed is a very important matter, and it is universally recognised that concrete is the most suitable material to adopt. The floor area can be divided into distinct sections as regards the usage, viz., the feeding passage, the feeding trough, the standing space, the gutter and the gangway or dunging passage.

The feeding passage should be formed as an ordinary concrete floor 6 in. thick, and if finished to a fairly smooth surface when the concrete is laid, no finishing coat will need to be applied subsequently, as a perfectly smooth surface is not desirable.

The feeding trough should be carefully designed to provide the maximum convenience and economy, and concrete is practically the universal material adopted for this part of the work, even when not used for other parts of the building. In the section of a cow-house floor which is illustrated in Fig. 61, the type of trough that is often used can be seen. It may either be semi-circular in cross-section or merely have sloping sides which converge inward towards the bottom, the latter being also given a slight slope. The former section is probably the most satisfactory, as it is a good form for food and is also suitable for water when the trough is made continuous throughout the whole length of the house, with a supply pipe at one end and a waste at the other. The width of the trough, inside, should not be less than 18 in., and where it can be provided a width of 2 ft. is preferable. The bottom of the trough, inside, should be level with the floor line and the height of the front edge should be about 13 to 15 in., while the back edge next the feeding passage can with advantage be higher, say, about 1 ft. 9 in., the additional height being formed above the semi-circular portion by splayed concrete, which facilitates the delivery of the food into the trough. The minimum thickness of the concrete at the bottom and sides should not be less than 3 in., and if the material is well mixed and of good proportions, no reinforcement will be necessary, although some designers prefer to insert a few small rods in the front portion to strengthen the concrete against blows and cracks. No rendering will be required to form a finish, if any irregularities in the surface are smoothed off as soon as the forms are removed or, at the most, the concrete need only be brushed over with a pure Portland cement grout if applied when the former is green.

The standing space should be formed with concrete 4 in. thick, laid with a fall of about 2 in. from the feeding trough to the gutter. This floor should

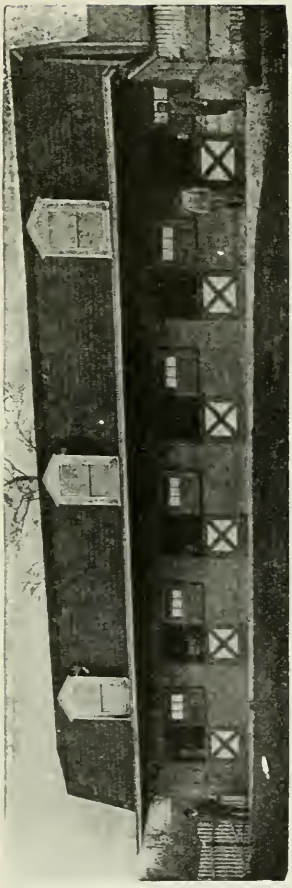

FIG. 63.—A CONCRETE COW-HOUSE.

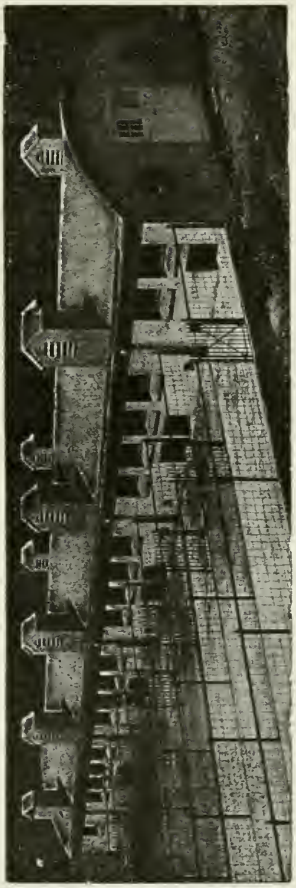

FIG. 64.—A CONCRETE PIGGERY.

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FIG. 65.—STALLS AND STABLES AT WHITECROSS STREET, LONDON (VIEW OF STALLS).

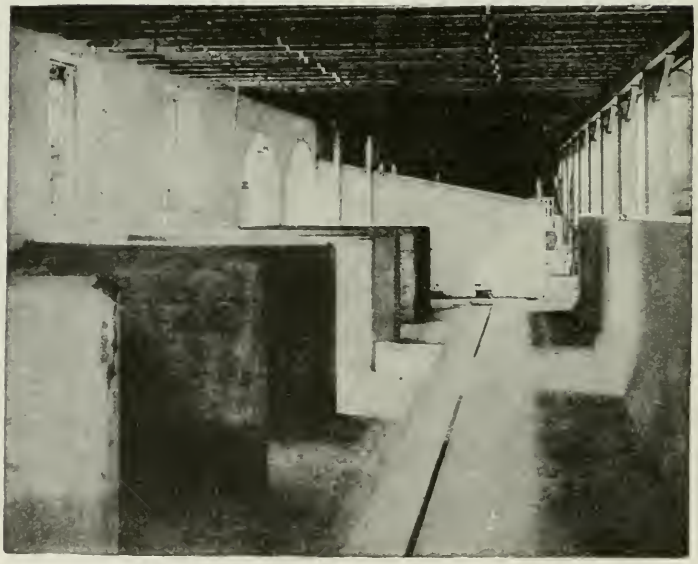


FIG. 66.—COWSTALLS, MANGERS, &C., AT WINNINGS FARM, MALVERN.

be grooved to afford a good foothold for the animals, and such grooves should be arranged to drain into the gutter at the back. It is advocated by some that the standing space should be formed of rammed clay for a width of about 4 ft. from the trough as this gives a more comfortable surface for the cows to kneel and prevents enlarged knees, but it does not possess the same merits of cleanliness and durability which are present with concrete, and the latter material is commonly used for the whole area. The gutter at the back of the standing space should be 2 ft. wide and about 6 in. deep with a small channel next the gangway, and towards which the floor of the gutter should drain with a slope of about 1½ in. This channel, which will convey the liquid from the gutter, should have a fall in its length and discharge into a gully at the end which is connected to a drain leading direct to the liquid manure tank. The whole of the gutter and channel can economically be formed in plain concrete, and this is the material recommended by the Departmental Committee of Small Holdings.

The gangway or dunging passage should be formed with 4 in. of plain concrete laid with a 2-in. fall towards the gutter, and thus the whole of the drainage will be to one point. The level of the gangway can, with advantage, be kept slightly below the level of the standing space, and this is accomplished by making the gutter 6 in. deep next the standing space and only 3 in. deep next the gangway. It can generally be stated that there is no material which can seriously compete with concrete for the floor, trough and gutter in a cow-house, either in cost or in suitability, and it is now almost universally adopted.

Roof.—This is preferable if of the pitched type, as the maximum amount of cubic air space is provided with the minimum height of walls.

A light concrete construction can be employed, similar to that mentioned for garages, but timber will usually prove the cheapest and best material.

There is no question of contamination and no great strength is required, and timber framing covered with concrete tiles will give sound construction with economy if the woodwork is designed to give rigidity without large expensive sections or waste of material. The need of providing ventilation to the roof space must not be overlooked, and wooden louvres will be quite suitable for this, although roofs are often ventilated by covering the slopes with boards fixed with a small space between. This latter method is not, however, so satisfactory as that of providing a permanent roof covering, such as concrete tiles or thin slates made with Portland cement and asbestos fibre.

Section III.

STABLES.

General.

The design of stables will depend very largely on the circumstances which govern each particular case, as the requirements in a large stable for valuable horses will be such as to demand a more expensive type of building than that justifiable on a small farm, but there are some general principles which will be applicable to all stable buildings.

Wherever possible the stable should be planned adjacent to the mixing house or fodder-room, it should be ventilated but not too strongly lighted, the stall for each horse should be not less than 6 ft. wide, the length from the back of the manger to the opposite wall should not be less than 15 ft., and the door to the external air should be arranged so that the horses are not placed in a direct draught.

Construction.

Walls.—The construction of the walls may be executed with concrete, either in the form of blocks or they may be monolithic in character, and the particulars given in connection with cow-houses will apply equally to stables, and, generally speaking, blocks will prove an excellent material.

Floors.—The floor should be of concrete about 6 in. thick, grooved and laid

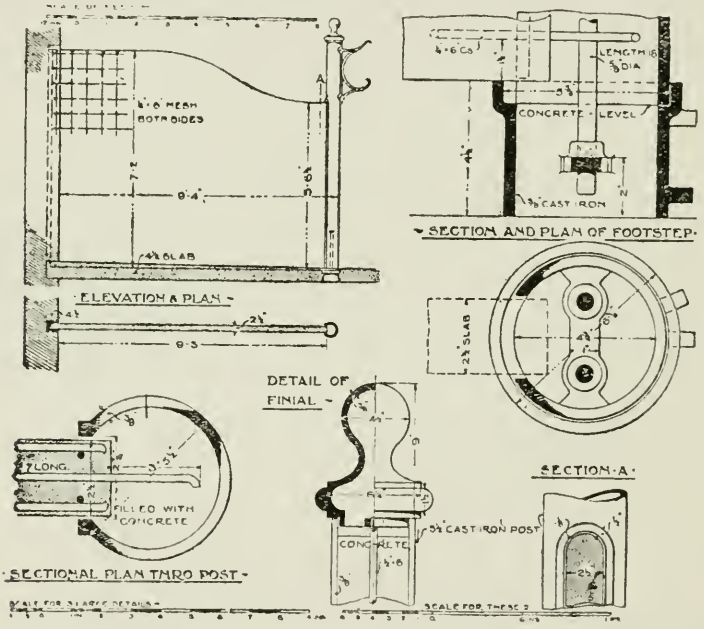


Fig. 67.—Details of Some Reinforced Concrete Stalls at Stables in Whitecross Street, London.

with a fall from the manger to the end of the stall when a channel for drainage should be provided, this being dished out in the concrete. The walking way, which is given along the end of the stalls, should also be of concrete, grooved and laid with a slight fall to the channel mentioned above.

Stall Divisions.—Reinforced concrete has been successfully used for the divisions between the stalls, and will be found much cheaper than those constructed with a combination of iron and timber. The divisions are usually about 7 ft. high at the highest point and about 9 ft. long, and good concrete 3 in. thick with $\frac{1}{4}$-in. diameter rods at 6-in. centres in both directions and surfaces will be sufficient. The divisions should be finished with a post at the free end, and

this may either be hollow cast-iron with an opening in the side for the attachment of the slab or a 6-in. reinforced concrete post can be adopted. The latter need only contain a little reinforcement, four ½-in. diameter vertical rods with a few links being sufficient, and if the rods in the slab are allowed to project into the post a very strong attachment will be given. Brackets or hooks for hanging up harness, &c., can be cast into the post at the time of concreting.

In the case of the slab it will be economical to cast this flat on the floor and raise into position afterwards to obviate double shuttering, and the rods can be left projecting at the end for connection to the post when the latter is formed.

Mangers.—The manger can be cheaply executed in concrete on the same principles as that described in the case of the feeding trough in cow-houses, but it will require to be raised above the floor level.

Lofts.—Where a loft is required over the stables, as is frequently the case the floor of this should be of reinforced concrete with ordinary beams and slabs, designed in accordance with general practice.

Roofs.—The roof may be constructed as a reinforced concrete flat, or it may be a pitched wooden roof covered with concrete tiles, as previously mentioned, and no special notes need be given here as to this portion of the structure.

Loose Boxes.—The construction of loose boxes, fodder-rooms and similar apartments can be executed constructed with concrete, on the same lines as mentioned for cow-houses, and concrete is also very suitable for cart sheds; but in the case of the latter, precautions must be taken to prevent damage to the walls when carts are being backed in. A "backing-rail" should be provided to protect the back wall, and solid concrete piers are necessary at the entrance, on either side, especially where a light form of block construction is adopted for the walls.

The illustration in Fig. 70 shows a farm building in course of construction, this comprising a harness room 12 ft. by 6 ft., a stable 12 ft. by 12 ft., a cowshed 12 ft. by 15 ft., and a double pigsty, the material used for the walls throughout being concrete blocks 18 in. by 9 in. by 4½ in., built to give a solid wall 4½ in. thick.

Section IV.

BARNS AND SHEDS.

Many sizes and types of barns and sheds are necessary on farms of all kinds, and concrete is eminently suitable for the construction of these, particularly for the floors and walls.

Walls.—Where large barns are required the walls should be in reinforced concrete, and it is essential to provide a dry building inside. In small barns concrete blocks may be used, but when corn is to be stored, or other materials affected by dampness, the walls should be built with a cavity.

Hollow block walls will prove satisfactory, however, in the majority of cases for all small barns and sheds.

Floors.—The floor in all cases should be of concrete, 6 in. thick, and it will be found that rats will not be a source of trouble when concrete walls and floors are employed, as is the case where wooden barns are in use. If the superstructure has to be constructed of timber it should be built on a concrete floor which is raised above the general ground level, and this can be done by forming several low piers of concrete which will support a slab, and thus no nesting place will be provided for rats. Bolts should be cast in the concrete for the attachment of the cill pieces which will be required to take the feet of the vertical wooden posts of the upper part of the building. The roofs generally can be of timber with a suitable covering.

Rick Stands.—Rick stands can be formed with concrete piers, and they form an excellent material for this purpose, and once cast in position no further expense will be incurred, while the ricks are kept quite dry, and no harbourage is given to rats, which will invariably be found in large numbers when the ricks are merely made on a layer of brushwood.

Section V.

PIGGERIES.

Concrete is an excellent material for piggeries, as pigs will thrive well on a concrete floor if it is laid to a good fall, and the building will be strong and sanitary while being very economical in cost.

Walls.—The walls only require to be 4½ in. thick, and the notes given in connection with the construction for other small buildings will apply generally to piggeries.

A very good example of a double pigsty built with concrete blocks is illustrated in Figs. 72 and 73. The walls are built of concrete 4½ in. thick, the blocks being 18 in. by 9 in. by 4½ in. and the roof is covered with concrete tiles (glazed red) which give a warm and absolutely watertight roof. The divisions in the pigsty are 7 ft. square with a courtyard to each 7 ft. by 6 ft., and in the courtyard there is a trough made entirely of concrete with a shoot from the outside wall to the trough for feeding purposes.

This building was erected on the estate of Wayford Tenants, Ltd., Norfolk.

FIG. 68.—COWSHED, FODDER ROOM AND DOUBLE PIGSTY.

FIG. 69.—HARNESS ROOM, STABLE, COW BYRE AND PIGSTY, WAYWARD WORK, NORFOLK.

FIG. 70.—A FARM BUILDING IN COURSE OF CONSTRUCTION.

FIG. 71.—A CREAMERY.

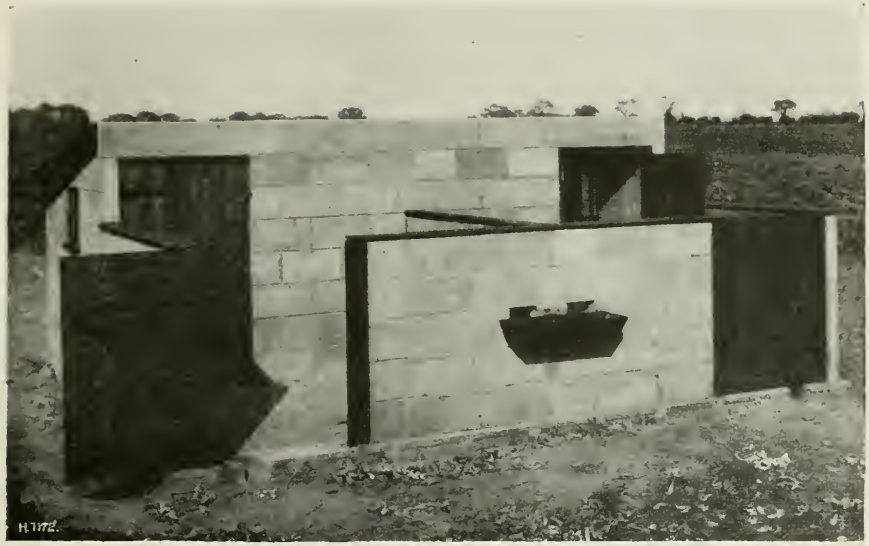


FIG. 72.—DOUBLE PIGSTY, FRONT VIEW.

FIG. 73.—DOUBLE PIGSTY, BACK VIEW.

To face p. 79.

FIG. 74.—A COW STABLE, EXTERIOR VIEW.

FIG. 75.—A COW STABLE, INTERIOR VIEW.

SECTION VI.

DAIRIES.

Numerous dairies have been constructed in concrete, as the merits of the material as regards its cleanliness have been recognised. It also has the great advantage that the building will be cool in the summer and warm in the winter, especially if the walls are constructed with concrete blocks built with a cavity, as previously explained. The whole of the walls and floor can be washed down, and washing troughs, shelves and similar details can be formed with concrete

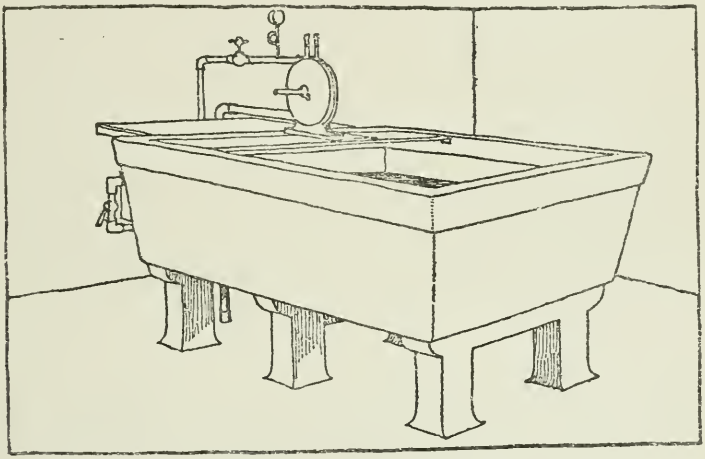


FIG. 76.—A CONCRETE BOTTLE-WASHING TROUGH FOR DAIRY.

to give a complete apartment. A large concrete washing trough is illustrated in Fig. 76, and a dairy building is shown in Fig. 71.

SECTION VII.

GREENHOUSES AND ROOT CELLARS.

Concrete is an ideal material for the construction of fruit-houses, greenhouses, root and mushroom cellars.

For fruit-houses the walls, floors and roofs, and the internal fittings in the way of shelves can be conveniently built with concrete.

For greenhouses, concrete is superior to wood, for it does not require constant repair, and saves fuel, as it retains heat and keeps out cold air. Greenhouses should have a foundation of 10 in. wide and 16 in. deep, or below frost level, formed of concrete proportioned 1 part of Portland cement, 3 parts sand, and 6 parts broken stone or shingle.

On this the walls should be erected about 6 in. or 7 in. thick, composed of 1 part Portland cement, 2½ parts sand, and 5 parts clinker or cake breeze, to the height required. The ridge should be 6 in. wide by 8 in. deep, and made of concrete

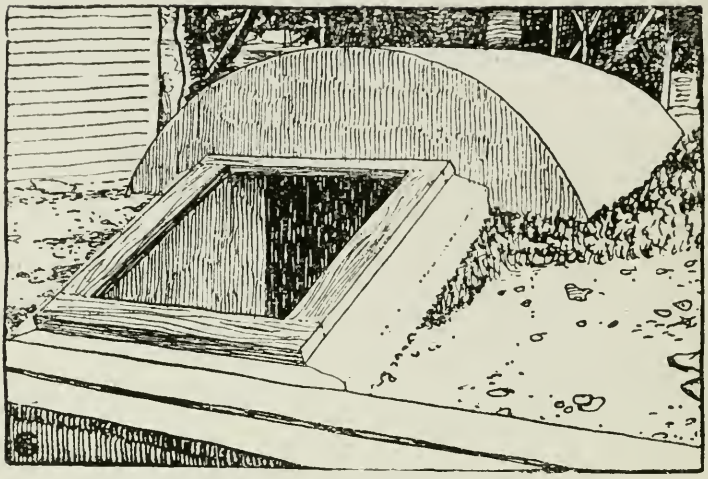


FIG. 77.—A ROOT CELLAR WITH CURVED ROOF.

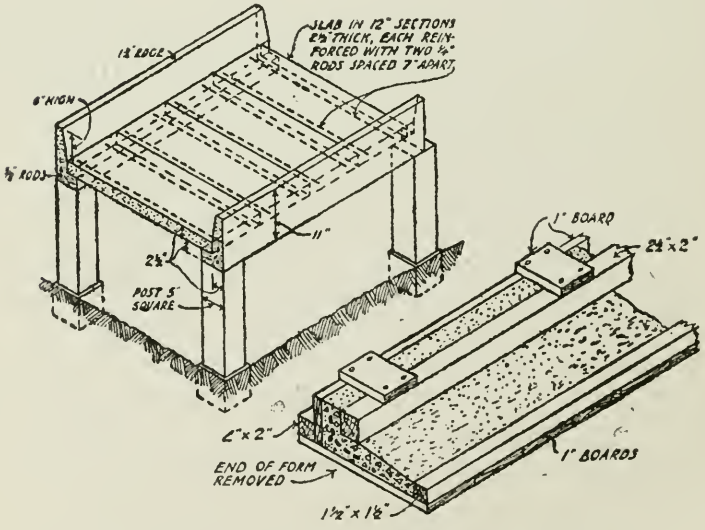
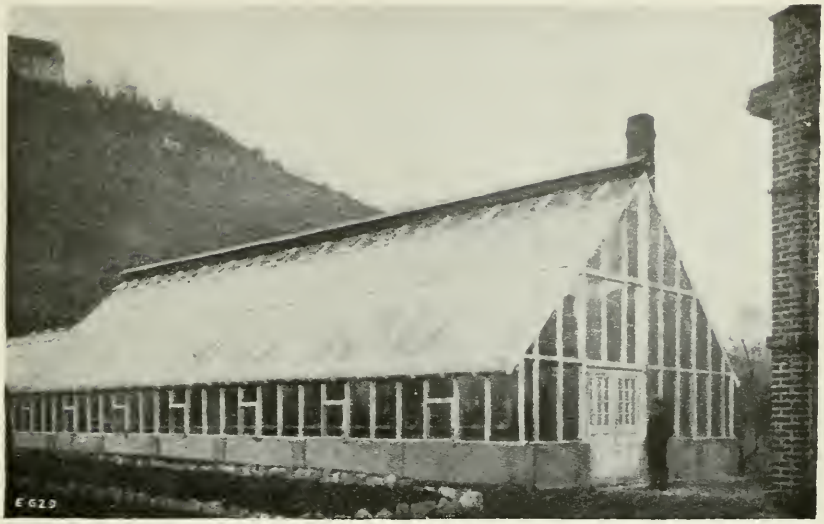
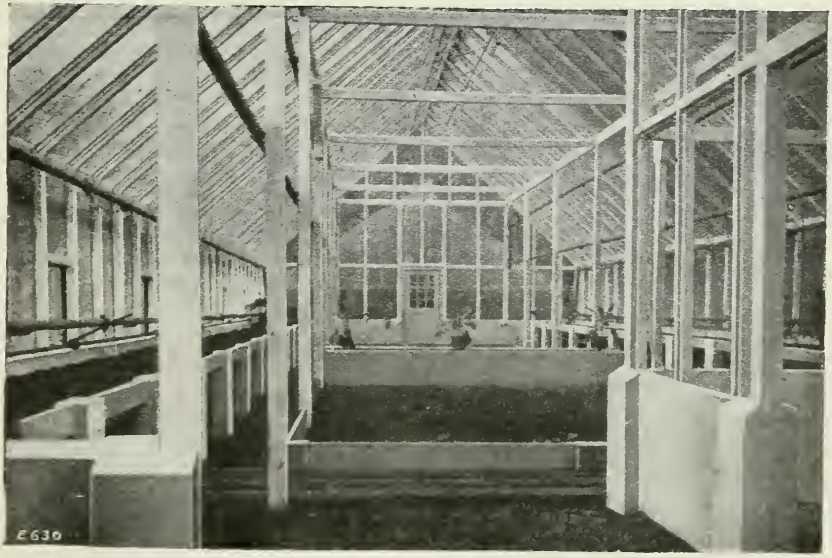


FIG. 78.—BENCHING FOR CONSERVATORY OR GREENHOUSE.

To face p. 80.





FIGS. 79 AND 80.—INTERIOR AND EXTERIOR VIEW OF A GREENHOUSE IN REINFORCED CONCRETE.

composed of 1 part Portland cement, 2 parts sand, and 5 parts broken stone or shingle, $\frac{3}{4}$ in. size, reinforced with two steel rods, say $\frac{1}{2}$ in. diameter. If the width of the greenhouse is not over 16 ft., beams $2\frac{1}{2}$ in. by 5 in. extending from the ridge to side walls, each reinforced with one $\frac{1}{2}$-in. bar, will be strong enough to support the sashes.

The ridge should be supported every 10 ft. by 12 in. square reinforced concrete posts. The tables and shelves may be made of concrete $2\frac{1}{2}$ in. thick, proportioned 1 part Portland cement, $2\frac{1}{2}$ parts sand, and 5 parts clinker, reinforced with a metal meshwork.

Hotbed frames can also be built with 3 in. concrete wall-proportioned 1 part Portland cement, 3 parts sand, and 6 parts broken stone or shingle resting on a 4-in. foundation.

The shelves and benching in greenhouses and conservatories should be of concrete also. The construction and moulds for same are shown in Fig. 78.

The excavation for root cellars, which are built half above and half below ground level, should be carried about 16 in. below the desired level of the floor, and round the sides a foundation of concrete proportioned 1 part Portland cement, 3 parts sand, and 6 parts broken stone or shingle, should be formed 12 in. deep. Between and slightly above these foundations 12 in. of porous material should be rammed over the whole area, exclusive of foundations. On the foundations a wall 18 in. thick composed of 1 part Portland cement, $2\frac{1}{2}$ parts sand, and 5 parts clinkers, broken stone, or shingle, should now be built, and a floor laid over the whole of the interior composed of concrete 4 in. thick. The roof may be as shown in Fig. 77 and formed of concrete. Near the top at each end window openings should be left in which a sash should be fitted after the concrete has set and the forms have been removed.

Mushroom cellars should be two-thirds below the level of the ground to obtain the best results; otherwise their construction is similar to that of root cellars.

CHAPTER III.

GENERAL INFORMATION FOR THE BUILDER.

Section I.

GENERALLY.

The use of concrete is becoming so general in all classes of work that its possibilities cannot be overlooked by any builder who is anxious to increase his business, and a thorough study of the economical production of the material and its satisfactory application to all parts of a structure is one which will undoubtedly form part of every builder's training in the future.

It is a subject which has been much neglected in the past, and concrete work has been looked upon as very simple and one which merely consists of mixing together a few materials, with any quantity of water, and throwing them into position. Concrete work does not, however, consist merely of plain concrete in foundations and over the surface of the site, but the execution of all parts of a structure with a material which is cheap and good when carried out on proper lines.

It has one distinction as compared with the majority of materials, and that is its manufacture by the builder on the site or in the yard, whereas with brickwork, timber, &c.. the materials are delivered in the finished state and only need application to the structure.

This fact should encourage the builder, as it increases his profit, but at the same time it calls for organisation, supervision and knowledge on the part of the contractor if good and profitable work is to be done. Good work is absolutely essential, and this cannot be too strongly impressed upon the man who is responsible for its execution, because the most efficient design and specification will be useless—except as evidence against the builder—if the work is carelessly done.

In cottages and small buildings generally concrete is becoming more universal, and it is in this class of work that the provincial builder usually finds the greater part of his business and, as the services of a specialist will seldom be justified in these small buildings, it is incumbent upon the builder to develop concrete construction on his own account in order to be able to build cheaply and well in this material.

PLANT.

The question of the plant for concrete manufacture is a very important one, and it will always be found economical, in the long run, if sufficient plant is provided to carry out the work quickly, while better quality will result.

In the case of a small business, when the capital is very limited, great care must be exercised in the selection of the plant, and the builder must carefully

consider whether he will have sufficient work to keep any machine going before the same is purchased because he cannot afford to keep capital locked up in plant which is idle. At the same time he will be called upon to enter into competition with other firms who have a complete plant, and his chance of producing work quickly, cheaply and well, will be small compared with his competitors unless he has certain essential machines.

The complete equipment for the execution of concrete work of all classes will be extensive and include such items as mixers, crushers, block, tile and brick machines, washers, moulds of various kinds, mechanical power in the form of engines or motors, hoists, skips, tram rails and wagons, shearing and bending machines, tampers, concrete spades and various tools, apart from the ordinary plant which is utilised for other classes of construction, as, for example, a circular saw, which is invaluable if a large amount of timber has to be cut up for shuttering.

Concrete Mixers.—A concrete mixer is one of the first essentials in concrete manufacture, as it saves time and labour and produces a good quality of uniform concrete such as cannot be obtained by hand mixing. The outlay entailed will soon be recovered by the builder in the saving of labour, and care should be taken to select a really good class of machine.

It is not proposed to describe here the good mixers which are on the market, as particulars of these will be found in "Everyday Uses of Portland Cement" and "Concrete and Constructional Engineering."

The mixer should be carefully looked after, kept properly greased at the moving parts and thoroughly cleaned out at the end of each working day on which it is used; and, with a little attention, it will last for many years. Where any large quantity of work is to be done, mechanical power is a necessity, and if a suitable engine is obtained this can easily be transported from one spot to another and be used for driving the mixer and also the crusher where the latter is required. Where stone is available in the vicinity of the work a crusher is absolutely needful, and as this should be adjacent to the mixer to avoid unnecessary handling of materials, it is a good plan to drive this by the same engine. The crusher and mixer should both be arranged at such a level that wheelbarrows can be run under the mouth of the delivery to discharge direct into them.

The jaws of the crusher can be adjusted to suit the size of the stone required, and they should be set to give the correct size and not continually changed about, as is sometimes done, because if two sizes are needed large batches of each should be crushed at separate times. Many parts of the plant are so general and simple as to need no particular mention, but are nevertheless very important, and an example of this is provided by tram-lines and wagons. The saving of time and labour by the use of temporary tram rails, which are well planned, is enormous, and they are quite essential in the complete modern plant.

There is one particular feature of the modern plant which has been extensively developed during the past few years, and it is one which is an important factor in the construction of small buildings, viz., machines for the manufacture of blocks, bricks and tiles of concrete, and some notes on these are given in the section dealing with block manufacture.

LAY-OUT AND SUPERVISION.

The general arrangements and lay-out of the machines and stores for concrete making are extremely important as affecting the cost of the work and also the quality.

There are two main points to be borne in mind when deciding in the arrangements to be adopted, viz. : (1) the need of reducing the handling of the materials to a minimum, and (2) concentration, to enable thorough supervision to be easily performed.

The arrangements for block making and similar work on the builder's permanent yard will naturally be based on entirely different conditions to those obtaining on a building site where blocks and mass concrete work are being executed. In the first case the lay-out can be on more or less permanent lines, but in the second case the arrangements are only temporary, and they may need to be varied as the work proceeds, apart from the fact that they will be done away with entirely when the particular constructional work, for which they were planned, has been completed.

The two main points as given above will apply in both cases, but the method of complying with them will naturally vary, and what might be reasonable and economical in the way of equipment in the yard would possibly not be justified on a building site.

YARD WORK.

In the lay-out of the yard equipment the moulding machines can be taken as the central point of operation, as it is here that the concrete is actually manufactured into the units which will be sold for building purposes. All the materials must be conveyed to and from these, and they are thus the pivot of the whole of the operations.

The principal operations may be said to be five in number, viz. : (1) Receiving and storing materials—cement, sand and aggregate ; (2) carrying materials to the mixer and combining them with water ; (3) depositing and moulding the concrete ; (4) removal of the blocks to the drying ground or curing chambers ; (5) removal and storage of the hardened blocks. There may, in addition, be a further operation in surface treatment where this is required, and this may be termed " finishing."

It is impossible to lay down any fixed plan for the lay-out which will be applicable to all plants, as so much will depend on circumstances, such as the source of the supply for the aggregate and sand, the available area for the concrete making and the magnitude of the plant. The ideal arrangement is one where the materials are stored close to the mixer and at the level of the top of the hopper which feeds this machine, while the block machines, or other moulding plant, are situated below to suit the level of the discharge from the mixer. As the block machine operators will, however, be situated at the ground level to avoid unnecessary lifting in conveying the blocks to the drying ground, it means that the raw materials must all be hoisted when they are delivered to bring them up to the desired level for such ideal arrangement, and although

this is sometimes done by conveyers of different types where the plant is extensive, it will not be feasible in the ordinary builder's yard, and a lifting hopper must be provided on the mixer, or inclined runways be given for the transport of the aggregate and sand up to the hopper level, and the cement should be stored close to the mixer on a raised floor.

When the plant is adjacent to a suitable gravel bank or other source of supply as regards the aggregate, the layout will be governed to some extent by this, but by the use of tram rails and trucks for transport it will be quite simple to get the supply to the mixer, even if the latter is some distance away, and no large storage for the most bulky of the materials will be necessary. It must be remembered that the storage of the aggregate and sand is an important matter, because if the materials are left out in the open they are liable to freeze and become lumpy in cold weather, which makes handling difficult, and the varying amount of moisture which they will contain at different times will make it more difficult to obtain a uniform mixture for moulding.

It will be found economical in the long run to provide a cover to all materials and plant which will enable the work to proceed regardless of the weather, and this will tend to a uniform quality of work executed by men who can perform their operations in comfort.

Storage of Cement.—Portland cement must be carefully stored otherwise it is liable to deteriorate in quality, and when it is necessary to hold a large stock it is preferable to store it in bulk rather than in sacks.

The storage shed should be thoroughly watertight and a timber construction with felt or asbestos tile roof should be adopted in preference to iron, as with the latter considerable condensation takes place under certain conditions of the atmosphere. The floor of the shed should be of concrete or wood.

In the latter case the timber should be well seasoned, laid with grooved and tongued joints, and raised at least 6 in. above the ground level to prevent absorption of moisture.

Division of Work.—Although separate operations should, as far as possible, be conducted in separate departments, these departments must be arranged in convenient relation to one another and with a proper regard to the sequence of the operations, but even while effecting this separation it is advisable to avoid unnecessary partitions, enclosures and doors as they interfere both with the work and the supervision. With a carefully arranged plant the supervision can be carried out at one or two points and the whole of the operations properly controlled. Efficient supervision is absolutely essential from the builder's point of view to prevent loss of labour by idleness, loss of material by carelessness, and possibly bad work by indifference, and he will be amply repaid for time and money which are spent in centralising the whole plant and instituting a complete system with thorough control by a competent supervisor.

Drying Ground.—The location of the drying ground or airing rooms must be considered in relation to the operating machines when the blocks are moulded, and, while providing for the maximum output, they should be close to the machines and not necessitate a long journey with the moulded blocks. If

possible the direction should be arranged so that there is a continual flow one way from the point of delivery of the raw material into the yard to the storage yard where the hardened blocks are placed, as this system will prevent any congestion or possibility of the transport of the finished material interfering with the movement of the cement, sand and aggregate.

SITE WORK.

The same general principles which are given for yard work will apply to work on the building site, but unless the scheme is a very large one it will not pay the contractor to expend a large sum of money to provide for ideal conditions where existing circumstances make this difficult. The storage of the cement must be properly provided for in a suitable shed, but the other materials will be stored in the open close to the mixer. The latter machine should be placed in a position which is accessible from the entrance to the site, as it involves considerable waste of labour if the sand and aggregate are deposited in a place which necessitates their transport afterwards over a long distance to the mixer. The work of gauging, mixing and moulding should be done at one spot, at a point which is convenient for the delivery of the materials and also for the buildings themselves, but the former point is almost more important than the latter, because the position of the work in the buildings is constantly changing, and what may be convenient at one time will not be convenient at another. The mixer and other plant can, of course, be moved about, but this will not pay unless the work is extensive, as it means the suspension of work for a certain period apart from the actual expense of removal, unless portable mixers are used, and even the latter complicate the deposit and handling of the raw materials. When blocks are being used the drying grounds should be arranged to suit the positions where they will ultimately be required, at the same time keeping the blocks sufficiently far from the buildings so as not to interfere with the general building operations. Generally speaking it is the best method to work the actual buildings toward the mixer, etc., rather than away from it, as this method avoids obstructions, and the necessity of crossing portions of the partly executed building with materials is reduced to a minimum. In building walls with concrete blocks it is advisable to provide for a double scaffold similar to that used for masonry work, as it is not desirable to leave out blocks for putlog holes, and the additional cost will be comparatively small. The method of procedure as regards the execution of the whole scheme should be carefully thought out at the very commencement, in order to avoid, as far as possible, a continual change of routes for materials, position of plant and offices, which involve expense without any return to the contractor. A good system is particularly necessary where reinforced concrete work is being executed, in order to allow the different sections to be carried out in their proper sequence and without delay or damage to work already done.

Where a large amount of shuttering is required, it will always pay to instal a circular saw for cutting the timber, as the saving in time and labour is con-

siderable, and it will be useful for general carpentry work throughout ; but if the site is close to the builder's own yard such work will naturally be executed there, and the greater part of the cutting will be done before the timber is delivered to the site. In this and other ways the procedure will be affected by the proximity of the site to the yard, and if they are close to one another the layout and general organisation on the site will be much simplified, as economy will be effected by doing all the work possible in the yard where stocks of material are available and better facilities exist for carrying out the work on a good system.

Local Labour.—There is a general impression among builders and others that the execution of concrete work requires the services of a large number of skilled men, but this is not the case, as in the greater part of the operations the work can be carried out by unskilled labourers, provided they are properly supervised and instructed in the particular operation on which they are engaged. Skill is necessary, but only on the part of the foreman or person directly responsible for the direction and control of the operations, because the whole of concrete construction in cottage work can be, and should be, reduced to a system in which the labour is more or less of a mechanical nature, and each man is a unit performing an operation which is simple and merely a repetition of what he has done continually since the commencement of the work, and, consequently, no special skill or brain power is required. It is not intended to imply that a certain amount of initiative on the part of the workmen is undesirable, but merely that highly trained men are not essential and, consequently, any available local labour can be utilised successfully.

The chief point to remember is that every man should be given sufficient instruction at the outset as to the method of executing his particular operation, where such operation is one to which he is not accustomed, and this instruction is not in any sense a matter entailing much time or training, but simply the necessary guidance of the skilled supervisor to render each part of the system complete. In some cases a little explanation of the principles to which the work must conform will be helpful, as it will be found that a simple explanation of the theoretical aspect will invariably arouse some interest on the part of the worker, and he will realise very quickly the importance of executing his work on a system, even if he is an unskilled labourer.

In the case of operators who are working block machines and similar appliances some instruction is certainly necessary at the commencement ; but here again the work is purely mechanical, and once the knack has been acquired by the workman no further teaching is necessary, and it is only ordinary labourers' work. Where brickwork is to be built skilled tradesmen must be employed, but for the greater part of the operations in concrete building there is no need to import tradesmen, as any local unskilled labour can be engaged, and the builder is able to effect considerable saving in expenses and wages, while the services of one highly skilled man to supervise the work will be essential, whatever method of construction is employed, if good work is to be done, and none other but good work can be advocated.

Section II.

ORGANISATION.

It is essential that the whole of the preparation for and the actual building of cottages should be organised in a thorough manner and be systematic, so as to prevent wastage in labour or materials. There is no section of the work which contains an element of uncertainty such as is sometimes met with in large buildings or engineering schemes where risk can be taken in the hope of making exceptional profit.

Records should be kept of the number of blocks produced per day, the exact quantity of materials required for their production, the cost of building the blocks in the work, the annual cost of repairs to plant and items of this description, in order to be able to trace any wastage or unprofitable department ; and the men responsible for each department should be made to realise that systematic work is expected.

The men should be selected for their suitability for each particular section of the work, and they should be kept to this from the foremen down to the ordinary labourer, and they will then speedily become a set of experts instead of a mere gang of unskilled and semi-skilled workers. The organisation should also be based on the correct principles which will facilitate expansion as occasion arises, it being much easier to introduce a new line into a well organised business than into one in which no system prevails.

It has been stated that a bad system is preferable to no system at all, and although this may be somewhat of an exaggeration, it contains an element of truth. In the case of a builder who takes up the manufacture of concrete blocks and organises this work on good lines, it is a simple matter to extend the work to include the making of concrete tiles, bricks and other concrete products which will materially assist him in connection with cottage building, as he will be able to compete favourably for all classes of work, and often obtain work by being able to suggest concrete construction as a cheap alternative to old-fashioned and less suitable methods.

The purchase of materials should be carefully considered, and no possible source of supply neglected if there is any hope of obtaining satisfactory materials at a lower rate than that being already paid.

In the case of the Portland cement, this should be obtained from a firm of high-class manufacturers who are reliable, and it will be found that better terms will be obtained if a large well-known firm is dealt with.

The cement should be purchased in large quantities, which need not necessarily be delivered at one time, but a contract can be arranged to ensure a constant supply as it is required. A new consignment should always be ordered in plenty of time, while a large quantity is still in hand, to avoid the possibility of the work being stopped through the cement running short. This is quite a common failure with contractors, and avoidable losses and delays are often caused through lack of proper organisation in this respect alone.

Aggregate.—The aggregate offers great possibilities for the business capacity

of the builder. Thorough investigation of possible supplies in the immediate vicinity will often result in an excellent material being found which can be obtained at a very low cost, and when this is the case the contractor should protect himself by getting a guarantee of a continuous future supply without the rise in price which is often asked when the use to which the material can be put is realised by the seller. Instances have been known of good material, such as clinker, being given away to the builder, who merely has to pay for carting ; but when it is seen that the material can be put to such a useful purpose as the manufacture of concrete, a price has instantly been put upon it which absolutely prohibits its economical use. It will be seen that it is impossible for a builder to price the cost of work accurately and ensure a profit unless his supply of materials is properly organised and in such a manner that he can command what is necessary to fulfil any contract either entered upon or contemplated.

Apart from the actual constructional materials used in cottage work, it is highly important to organise other sections of the work, such as the joinery. The doors and windows, together with the frames, should be standardised, and be made or purchased in fairly large quantities. For concrete work *in situ* the forms should be standardised and kept quite simple, and it will pay to construct these in a thorough manner which will permit of their removal and re-use several times.

Conclusion.—Before completing this section it may be well to summarise in a general manner and give the contractor the chief points to bear in mind when dealing with concrete construction for cottages.

These points may be stated as follows :—

(1) Study concrete manufacture thoroughly.

(2) Build up a reputation by good work.

(3) Acquire sufficient plant of good quality.

(4) Work on a thorough system, and lay-out the work to suit the system.

(5) Employ at least one thoroughly skilled supervisor.

(6) Do not neglect any opportunity for making concrete products and do not confine the operations to blocks only.

(7) Arrange the site work and yard work in conjunction with one another.

(8) Employ local labour.

(9) Instruct the men at the outset as regards the particular machine they are to operate.

(10) In the case of blocks and partition slabs, make certain that they are sufficiently cured before use.

(11) Organise thoroughly, both in office and works, and standardise wherever possible.

(12) Purchase on a large scale and in the right market.

(13) Thoroughly investigate the possibilities of all local materials for aggregate.

(14) Gain the confidence of architects and clients by fulfilling every contract in the spirit as well as in the letter.

Section III.

BLOCK MAKING.

The use of concrete blocks is so general for concrete cottage construction that some practical notes on this part of the work should be of assistance to the builder who is taking up the method.

There are many different makes of moulds and machinery on the market for the making of concrete blocks in such quantities and at such a price that they may be a commercial success. The machines can be divided into two groups : (1) The mechanical pressure machine ; (2) the hand tamping machine.

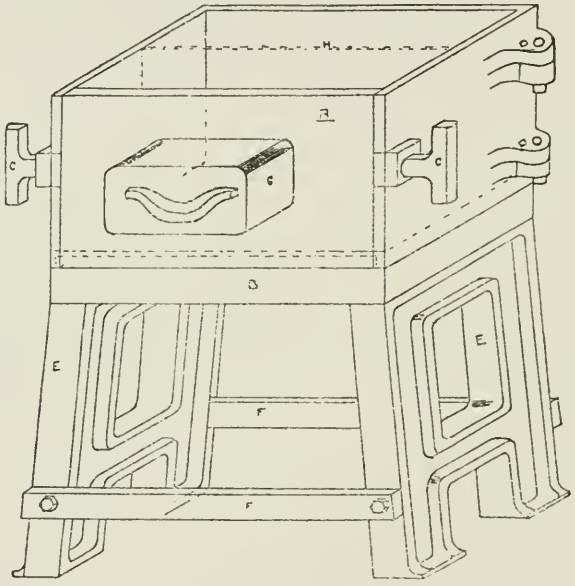


Fig. 81.—A Hollow Concrete Block Machine.

A. Mould Box.
B. Bed Plate.
C. Instantaneous Fastener.
D. Hinges.
E. Standards.
F. Stay Bars.
G. Core. This can be handworked by a Lever.
H. Division for Cavity Blocks.

The pressure machines are all about the same type ; that is to say, the machine compresses the material, the die or press coming down from the top and entering the mould box. Some machines apply more pressure to the block than others, and it is necessary to compress the materials so close together as to fill all the voids. Unless this is done, a waterproof and dense block will not be obtained. It is always best before purchasing a machine for any concrete block work to have the advice of a specialist, so as to get the best machine for the amount of capital to be expended, and he will also be able to advise the best methods of making, curing, etc., of the blocks or any other articles to be manufactured.

Hand tamping machines are more in everyday use than the power or mechanical pressure machines, for many reasons : (1) Because they are easy to transport from one place to another ; (2) because they are cheaper, and thus

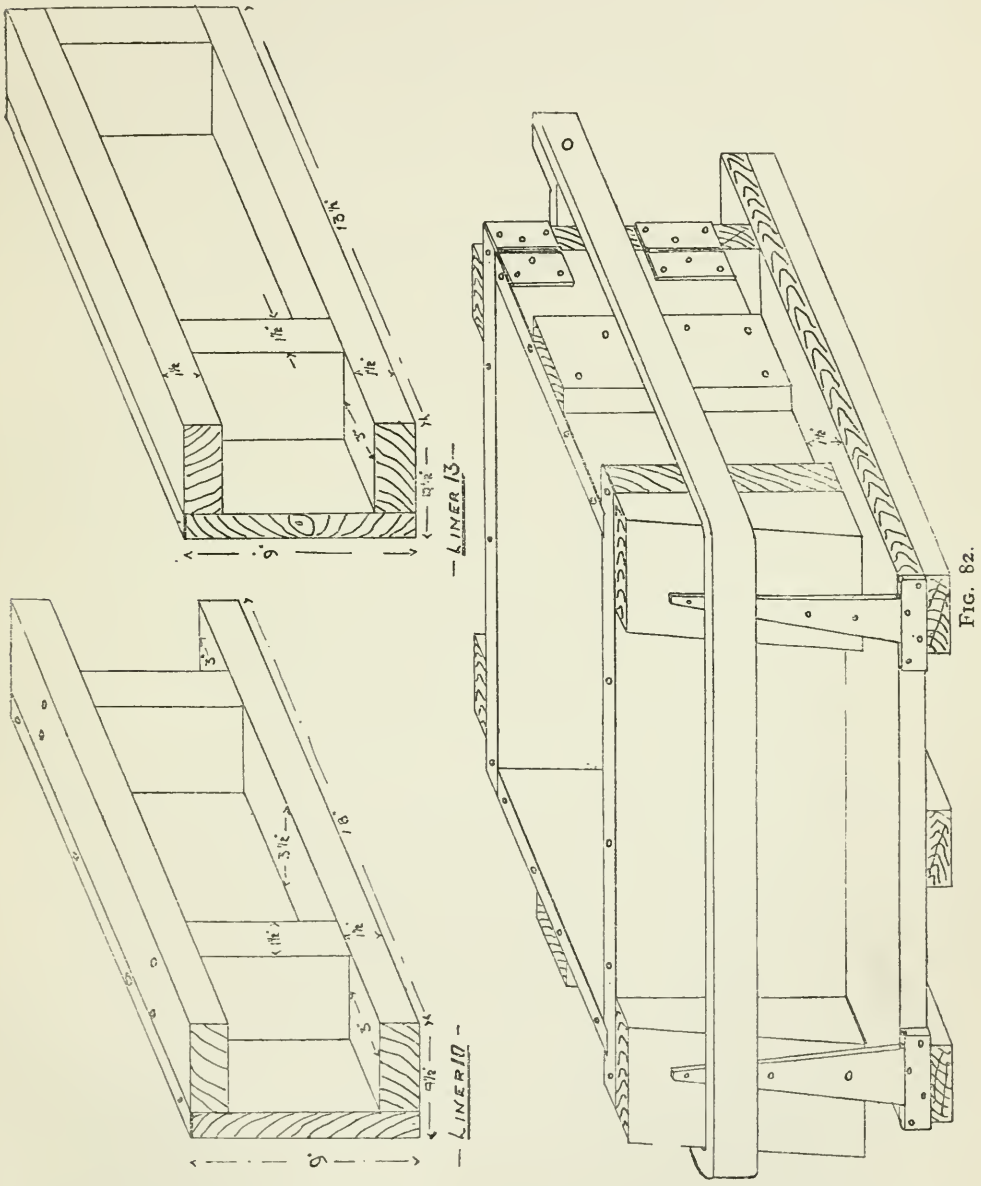


Fig. 82.

within the reach of small builders ; (3) because some maintain that stronger blocks are obtained by hand tamping than by the mechanical presses. This question will be dealt with later on under the heading of " How to Make Blocks."

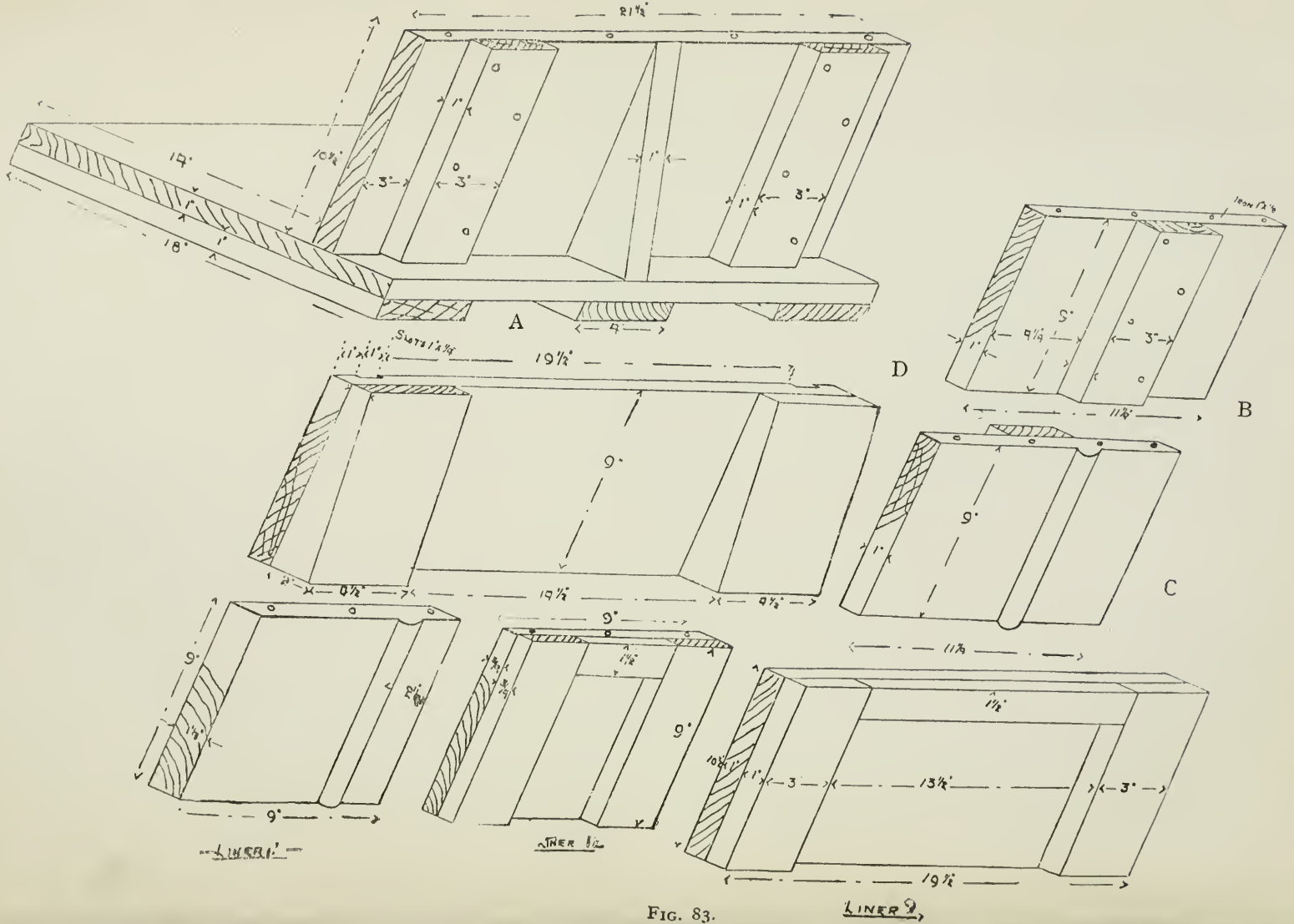
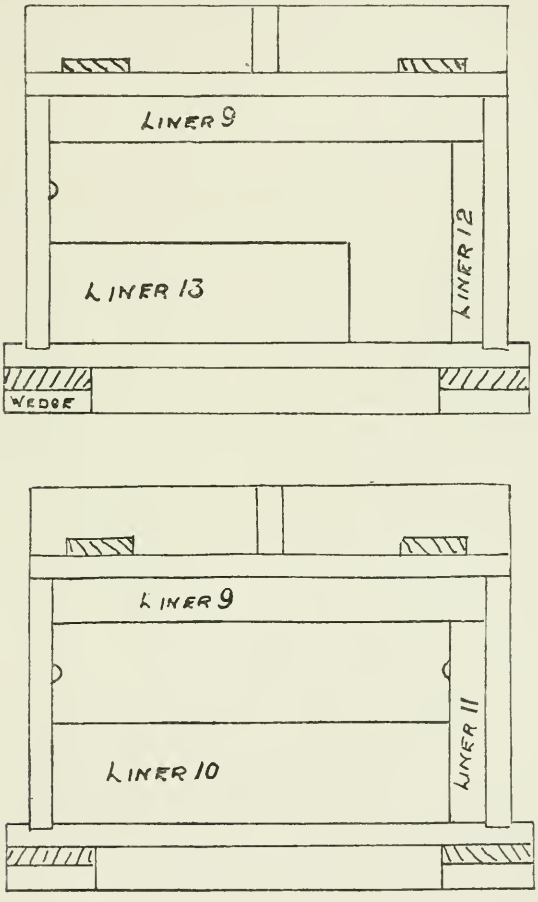


FIG. 83.

An illustration of a hollow concrete block machine is given in Fig. 81. This represents the general principle of a hand tamping machine. By taking the core *G* out and inserting a thin plate in the opening, the thickness of the door of the mould box, and also by arranging a division at *H*, cavity wall blocks 4½ in. thick can be made.

Making a Mould for Concrete Blocks.

The size block which has been found from practical experience to be the



FIGS. 84 AND 85.

handiest size for all general work is the one which is 18 in. by 9 in. by 4½ in., or thereabouts. It is always well to have a block of such a size as will give a complete number of blocks to the yard super. If the above size block is adopted it will be found that eight such size blocks will just cover a yard super. This makes it very simple for calculating the number of blocks in a wall which contains so many yards super of block work.

For the purpose of showing how to make a mould for concrete blocks, we will adopt this size as the standard size for the blocks. Fig. 82 shows the mould constructed without any "liners" on it. It will be seen from this that it has a bottom and a back which are fixtures, while it has two side doors which open out away from the mould. The front also opens and hangs down under the mould. The liners are so arranged that they can be easily taken from the mould and others substituted, so as to make different sized or shaped blocks. By this

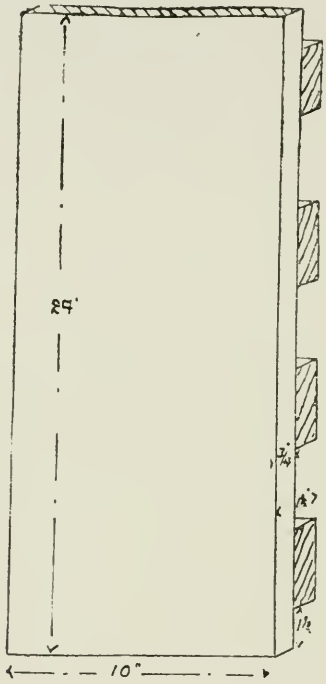


FIG. 86.—PALLET FOR BLOCKMAKING.

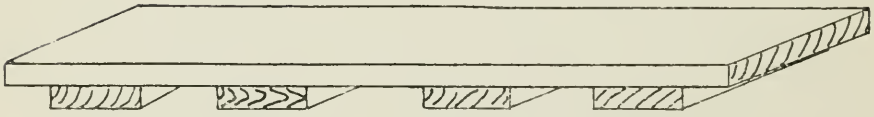


FIG. 87.

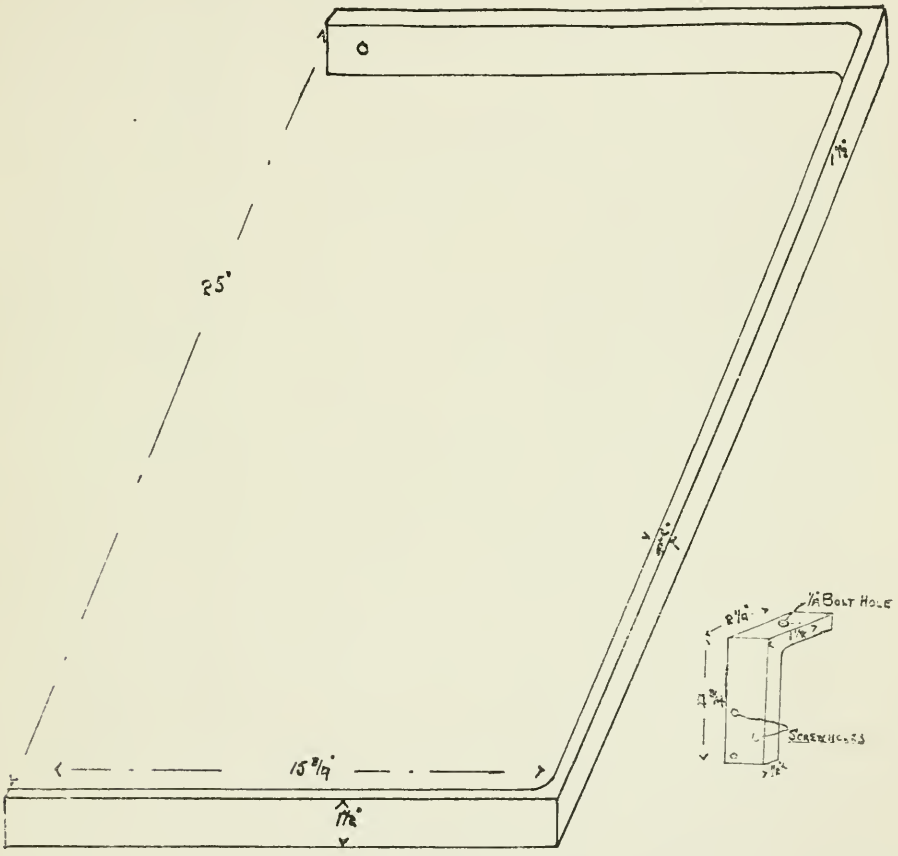
method the necessity for several moulds is obviated, but at the same time it is quite as convenient.

Fig. 85 shows the plan of the mould box fitted with the necessary liners for making ordinary 18-in. by 9-in. by 4½-in. blocks; while Fig. 84 gives the plan of the same mould with the liners in their place for making corner blocks.

Fig. 83 A illustrates the construction of the bottom and back of the mould box in detail, while B is the right-hand door. It will be noticed that this and the other two doors are 1½ in. shallower than the back of the mould. When hanging

the sides to the back, the top of the mould must be kept level. This will then allow the pallet to lie on the bottom of the mould and the side doors swing over it. There should be just sufficient clearance, so that the doors do not rub the pallet. C shows the left-hand door with a rib on it, which forms a groove in the block. D gives the detail of the front door, and it will be seen that it has two slots in it, and into these slots the side doors (B and C) fit.

Liner 9 shows the detail of the liner which is fixed to the back of the mould,



Figs. 88 and 89.

and is the same for ordinary and for the corner blocks. Liner 10 is also shown in detail, and this fixes to the front door, while Liner 11 is fixed to the right-hand side door. This constitutes the whole mould for the making of blocks 18 in. by 9 in. by $4\frac{1}{2}$ in. All liners should be fixed to the doors, etc., by means of screws from the outside of mould box. This obviates the necessity of damaging the face of the liners by screw holes, which will always show upon the finished article, *i.e.*, the block.

Liner 12 shows the liner which is attached to the right-hand side door when

corner blocks are required, and Liner 13, Fig. 82, shows the construction of the liner for the front door, which is also necessary for corner blocks. The position of the liners are indicated in Figs. 84 and 85, and from these it will be found very simple to fit up the mould.

Fig. 86 shows the pallet (upon which the blocks are made) in detail. The plain side of this is the face, the battens resting upon the bottom of the mould. It must be clearly understood that if 100 blocks per day are to be made it is necessary to have 200 of these pallets, as each block must be made on a pallet, and they require to be left upon the pallet for at least two days. It will, therefore, be readily understood that it is necessary to have sufficient pallets for at least two days' work. Upon the third day the blocks can, with care, be taken from the pallets, and these can then be used over again. It will be found advisable to have the corner blocks on the pallets for at least three days. The blocks should be watered each day after making so as to allow the cement to get its proper action. Figs. 88 and 89 show the arrangements for the iron fastener, which will hold the mould together tightly, while the blocks are being tamped. It is a very simple arrangement, but it is very effective and very quickly operated. Fig. 88 is simply a piece of $1\frac{1}{2}$ in. by $\frac{1}{2}$ in. iron bent to shape, while Fig. 89 is a bracket which is screwed to the back of the mould, and about $2\frac{1}{2}$ in. to 3 in. from the top edge of the mould. Two of these brackets are required to the set. In each of the brackets are $\frac{1}{4}$-in. holes, which are matched with holes in Fig. 88. Through these holes $\frac{1}{4}$-in. bolts are fixed with just sufficient clearance so as to allow Fig. 86 to move freely. The bolts form a pivot upon which the fastener (Fig. 88) works.

The mould should be made in yellow pine or American white wood, but, of course, other wood such as a good class red deal would do, but it will not stand so well. The top edges should be lined up with strips of iron about $\frac{1}{8}$ in. thick, which will protect the top edges from chipping and wearing. The outside of the mould should be painted, while the faces of the liners, etc., should be given three or four coats of French polish, put on with a brush, or two or three coats of shellac dissolved in methylated spirits. This will keep out the wet. Fig. 87 is an alternative type of pallet which is more convenient to handle for the ordinary walling blocks (18 in. by 9 in. by $4\frac{1}{2}$ in.).

How to make Concrete Blocks.

Pressure Machines.—If a mechanical press is used all that is necessary is to place a pallet on the bottom of the mould box and to fill it up with the material which is struck off level with the top, and then to move the box under the die. The die is then lowered by various means and the pressure is applied. After this is completed the die is raised back to its "rest" position and the mould box moved to the place where it was filled. It is then unfastened and the block taken out and laid on one side to harden off for 24 hours, and the operation again repeated. It must be noted that for each block that is made a pallet or carrying-off plate is required. In some of the power presses it is possible to make 1,000 to 1,600 blocks per day.

Pressure machines are quite suitable for partition slabs and cavity wall blocks, but for hollow blocks they are not quite so efficient. With hollow blocks, the cores which form the hollows must stand upright in the mould so as to allow the pressure, when applied, to disperse with equality throughout the block. This necessitates the face of the blocks (*i.e.*, the side of the blocks which are exposed to the weather) being on the side, and it has been found from experience that when blocks are made with their faces on the side, that they are not so weather resisting as if made on a face up pressure machine.

When hydraulic pressure is used a more condensed block is obtained, but the rapidity with which they are made is greatly reduced.

Hand Tamping.—Now we will deal with hand tamping. This is a simple process, but unless carried out in a perfect manner it will be found that the blocks are slightly porous, but if the following instructions are carefully followed satisfactory blocks can be obtained. Having selected the machine you intend to use, it will be found that for outside work it is necessary to *face* the blocks This means that a block which is composed of a mixture of 6 aggregate to 1 of cement has a facing of fine material which is mixed with 2½ of washed sand to 1 of cement. This face is only about ½ in. thick, and makes the blocks more impervious to the weather than if it were the 6 and 1 mixture throughout. If a face down machine has been purchased it is a simple method to make the blocks. First, the pallet is placed in the mould and then the facing material is filled in. This should only be about ½ in. in thickness. Upon this the 6 and 1 mixture is filled, and the whole is tamped or rammed down together. Before the next layer is filled into the mould the face should be "scratched" with a scratcher. This ensures perfect adhesion of the second layer to the first. The second layer can then be filled in, and the tamping operation repeated, and this face should also be scratched, and so on, until the block is completed.

If a "side face" machine is used it is not quite so easy to have the fine facing of even thickness, but with a little care this can easily be got over, but nearly all the hand tamping machines which are upon the English market are "face down" machines.

When coke breeze is used for making blocks it will be necessary to have a fine facing of washed sand, mixed 2½ of washed sand to 1 of cement. The backing material could be composed of 3 of coke breeze, 3 of sand and 1 of cement. This will ensure a fairly waterproof block. The same applies where pumice or any other porous material is used for building blocks.

The various types of block-making machines with their accessories have been illustrated and described in various issues of *Concrete and Constructional Engineering*, and need not be dealt with here.

Curing.—This is an all-important item in the manufacture of concrete blocks, and unless they are properly "cured" it will be found that they will have the tendency to crumble. By "curing" is meant the ageing, and thus the crystallisation of the cement. To obtain perfectly satisfactory blocks the following instructions must be strictly adhered to. As mentioned before, the mixture for blocks is only wetted to a semi-dry consistency, and it is common

knowledge that in order to obtain the hardest concrete a fair amount of water must be used. It will be said, "Then how do the blocks described here harden?" But there is a simple method, and that is the "curing," by which it is possible to harden the blocks just as well as if mixed wet. The method of curing is as follows :—

After the blocks have been made 24 to 48 hours, according to their shape and size, they are removed from their pallets and laid out in the curing yard in rows, and a passage left so as to enable a man to get between every third row. This will allow a man or boy to go between and water either with a can or hose. This watering must be carried out every day for six or eight days. If it is hot weather it may be necessary to water twice a day. This is the "curing" process, and it is well to remember that too much water cannot be applied to the blocks. After this they can be stacked up to dry off until wanted for use, but they should never be used under a month at least. They should be protected from the sun and also from frost.

If it is necessary for blocks to remain on the pallets longer than 24 hours, they must be watered while they are on the pallets, and they should always be watered within 24 hours of their being made, and the watering must then be continued as before described.

Where a very large number of blocks are to be continually made and the outlay is justified, special chambers for steam curing are constructed, and these should be designed and fitted up in accordance with recognised practice.

CHAPTER IV.

DESIGNS FOR COTTAGES.

INTRODUCTION.

Some excellent examples of artistic and useful cottage design are given in the following pages, and they illustrate very forcibly the possibilities of concrete as a solution to the problem of providing housing accommodation for the working classes at a reasonable rental.

Many hold the opinion that the use of concrete would lead to monotonous dwellings, but if the subject is properly studied it will be found to afford a very wide scope for the designer, and many pleasing effects can be obtained at comparatively little expense.

The essence of successful design is that of obtaining a good proportion both in individual features, such as openings and projections, and in the whole structure, and it is only in this way that the eye can be satisfied. Elaborate ornamentation is not essential, and in fact is to be avoided, because it involves unnecessary expense, and a simple building which is well proportioned will be far more pleasing and more truly represent the purpose for which the dwelling is intended. Perfect symmetry is not necessarily essential provided the design is well balanced, but a symmetrical lay-out will invariably prove cheaper than one which is unsymmetrical.

The plan should be straightforward and simple, with no waste space, and eccentricities should be avoided. There is a great tendency to strive for originality at all costs, and some designers prefer a type or feature which is original and unsuitable to one which is ordinary and quite satisfactory. This leads to designs which are often displeasing, whereas the designer who possesses a natural talent, and who strives for simplicity and good proportion, will soon begin to express his individuality in a manner which leads to satisfactory results because it is spontaneous. Originality is a decided asset to the designer, provided it is governed by the principles of good design and the conditions of reasonable cost.

PLANNING.

In cottage work the plan should be carefully considered in the first instance, and this should not be hampered in any way by a preconceived external appearance, but the latter should follow naturally from the former.

A good simple plan will always allow of a satisfactory external treatment and it is only in minor details that the latter should govern the former, and it is then rather a case of considering the two in relation to one another for the purpose of satisfying the conditions of external appearance without undue sacrifice of convenience and light as indicated on the plan. The plan should, however, be considered with a proper regard to the cost of construction, as by a judicious arrangement of the walls and fireplaces, the construction can be greatly simplified and the total cost kept down.

CONCRETE COTTAGE COMPETITION.

Considerable interest was aroused among architects and others by a competition which was organised by the proprietors of "Concrete and Constructional Engineering," who offered substantial prizes for the best designs for cottages suitable for execution mainly in some form of concrete, at a cost not exceeding £125, and as these designs illustrate the successful manner in which the material can be applied, they are reproduced here, together with the Assessors' Report and comments.

THE ASSESSORS' REPORT.

The Assessors express their satisfaction with the number and general character of the designs, which show the interest taken in the simple, but important, economic problem of cheap cottage building.

The special character of the competition is its demand for a design suitable for execution mainly in some form of concrete, instead of wholly in the usual materials of brick, tile, slate, stone, or carpentry.

This requirement necessarily affects the planning by imposing great simplicity of external form. It also tends to exclude or render superfluous the picturesque breaking up of the elevations.

The architectural problem is, therefore, not so easy as it is simple, precedents not lying at hand in the countryside or in local county traditions.

The conditions of concrete construction and design being granted, the main problem is the provision of the best accommodation possible for the fixed limit of expense.

The conditions explain that the sum of £125 is exclusive of builder's profit, sanitary fittings (which would be of stock prices), fences, land drainage, etc. The cost of the drains was expressly excluded, so that comparison could not hastily be made with the cost of completed cottages, which may or may not have been connected with sewers or have involved expensive drainage. The sum of £125 was settled for the purposes of the competition, and must not be taken as the total cost of completing any of the cottages.

The arrangement of the plan within these limits is the remaining but pre-eminent condition—domestic economy and the requirements of three bedrooms for the family with the living room and necessary adjuncts ruling the decision and leaving no space to be wasted.

The Assessors award the first prize to Design No. 206, the second prize to Design No. 75, the third prize to Design No. 193, the fourth prize to Design No. 205, and the fifth prize to Design No. 56.

(Signed) MAX CLARKE,
BERESFORD PITE,
EDWIN O. SACHS.

COMMENTARY ON THE COMPETITION.

The result of this competition is decidedly interesting, both from an architectural point of view and as helping to solve the economic problem as to the best means of housing the rural population who are in receipt of a very small weekly wage, and consequently unable to pay even a reasonable amount of rent for a cottage. Much time and thought has been expended in attempts to decide how much accommodation shall be provided in order to decently house a growing and increasing family, so that there may not be overcrowding.

Naturally some happy medium must be arrived at which seems to have been met by the conditions of this competition. It provides for a living room or kitchen and sleeping accommodation for father, mother and four children, which may be interpreted as a kitchen, three bedrooms and a scullery or wash-house, with places for food, fuel and sanitary accommodation. In country districts the provision of sink, w.c., and the drainage thereto, if water-borne sewage is contemplated, usually involves an outlay out of all proportion to the cost of the main building, and the question as to whether a detached earth closet would not meet all the requirements of health and sanitation is one which merits the careful consideration of those who are interested in the housing problem, so that some broad principle should be agreed upon. This point has not received the consideration it deserves.

Another matter which is of great importance in the housing problem is the area and the height of the rooms. It is one thing for rooms in town dwellings to be at least 8 ft. 6 in. high, but it is quite another matter in the country where all the doors and windows can be left open, and where probably the occupants spend the greater portion of their life out of doors. In the latter case it might reasonably be presumed that a less height than 8 ft. 6 in. would be sufficient, without any detriment to the health of the occupants.

All these questions are of vital importance in the production of an economical design. The grouping of a number of cottages no doubt tends to economy, but in cases such as the present problem, cost is the first consideration, and groups, instead of isolated buildings, would appear to be one step which should be agreed upon as giving the best return for a fixed outlay.

The public generally, and some designers, do not seem to differentiate between a cottage for the labouring classes and a "week-end" cottage. Money is wasted on the little extravagancies of the latter which are quite out of place in the former, as the less weekly rent a cottage can be let for, the greater the advantage conferred upon the occupier. Questions such as these led the proprietors of "Concrete and Constructional Engineering" to promote this competition and to offer five prizes the aggregate value of which amounts to the very handsome sum of £204 15s., the first prize being 100 guineas, the second 50 guineas, the third 25 guineas, and two prizes of 10 guineas each.

A large number of drawings, 249 sets in all, were sent in, amongst which nearly every type of cottage was represented in some form or another.

In most parts of the country the materials for the aggregate of concrete can be obtained in some form, and if the material is dealt with in a proper manner

the construction can be made efficient and lasting with a minimum of cost for upkeep, an important item from the owner's point of view.

The assessors therefore decided that those designs in which concrete was largely used complied to the greatest extent with the requirements of the conditions, and as a result selected design No. 206 as the most suitable to which to award the first prize of 100 guineas. It is an isolated one-storey cottage, in which concrete is used throughout, having an excellent plan with a central living room 185 ft. in area, and three bedrooms, being 102 ft., 106 ft. and 125 ft. in area respectively. There is a scullery 56 ft. in area and food store off the scullery, and a w.c. and fuel store, both entered from the outside. The rooms are 8 ft. in height, and there is no waste space whatever in the plan, the whole being conveniently arranged with a view to economy of labour in carrying out the domestic duties of the housewife. The windows are so placed that each room will get sun during some hours of the day. The flat roof adopted, while being somewhat novel in design, would be a pleasing feature in the scheme, and is skilfully treated so that only one rainwater pipe is required. The author is to be congratulated on his clever treatment of the problem, and it is to be hoped the design will be carried out at an early date. The total cube is 8,130 ft., and the estimate cost is £125 10s. This sum, according to the conditions, does not include drainage, water supply, sanitary equipment or plumbing, and the work to be carried out by an owner buying his own materials and employing direct labour.

The second premium of 50 guineas goes to design No. 75, a one-storey pair of cottages. In this concrete is also used throughout for the construction. There is a central living room 154 ft. in area and three bedrooms, having areas of 126 ft., 68½ ft. and 68½ ft. respectively, the scullery is 44 ft. in area, there is a food store entered from the scullery, and a w.c. and copper both outside. The rooms are 9 ft. high to the collar of the roof, and about 7 ft. 6 in. to the junction of the sloping roof with the wall face.

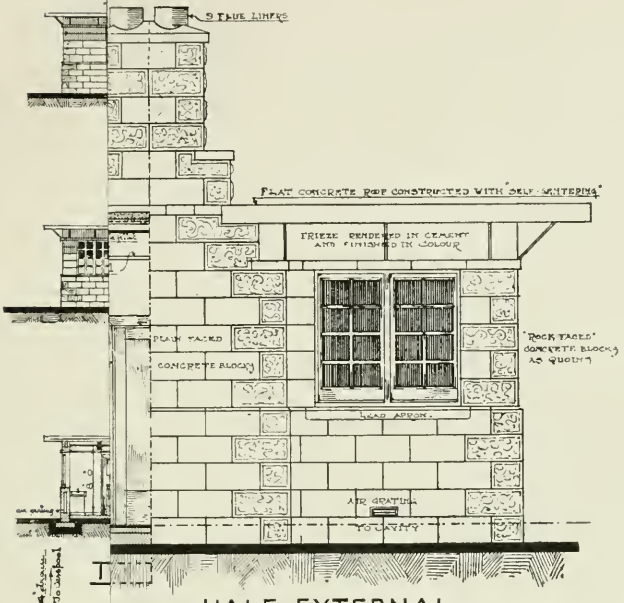
The total cube for the two cottages is 14,362 ft., and the estimated cost is £249 6s. 10d. at 4⅛d. All the windows face east or west, there being none at the ends. Any number of cottages could be built in a row at a minimum cost. The roofs are sloping, covered with some form of cement tiles, and the small projecting porches constitute a pleasing break in the long line of the frontage to the west.

Design No. 193 takes the third place, with a premium of 25 guineas, a pair of two-storey cottages, concrete being the material used. In this design there is a central living room with a scullery and one bedroom on the ground level, and two bedrooms on the first floor.

The living room is 151 ft. in area, and the three bedrooms 169 ft., 142 ft., and 71 ft. in area respectively; the scullery is 73 ft. in area; a food store is entered from the scullery, and a w.c. and fuel store both outside the house. The rooms on the ground floor are 8 ft. 3 in. high, and the two bedrooms on the first floor are 8 ft. 3 in. average high. The exterior is treated with projecting bands of concrete and a rather expensive cornice for this class of house, which might well be simplified in execution. The pitch of the concrete roof is very flat and

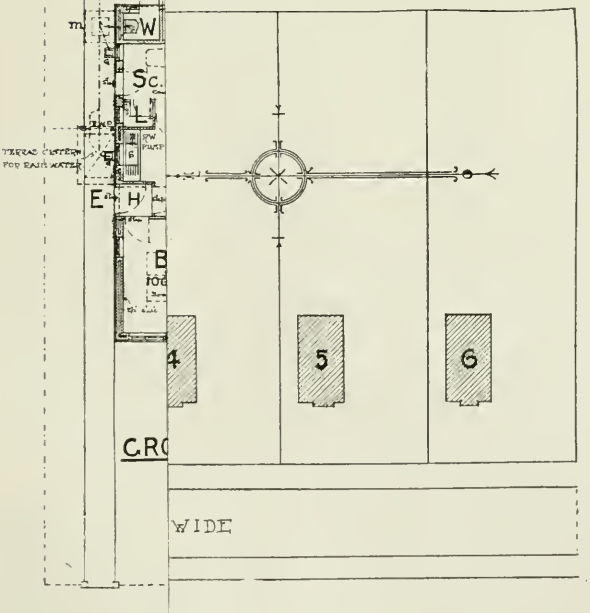
To face p. 102.

E.



HALF EXTERNAL.

ELEVATION.



AN

INCH

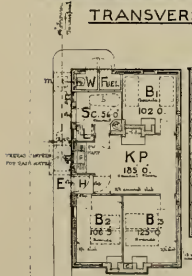
£125 CONCRETE COTTAGE.

EAST. NORTH.

WEST SOUTH.

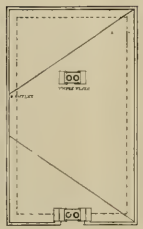
ELEVATIONS.

TRANSVERSE AND LONGITUDINAL SECTIONS.



ROOM	DIMENSIONS	AREAS	HEIGHTS	CUBIC CONTS
H	3·6 X 3·6	12 3	8 6	102 0
KP	12·0 X 11·0 / 5·6 X 3·6	183 0	8 0	1160 0
Sc	8 6 X 6 3	56 0	8·0	448 0
B1	10 0 X 10·3	102 0	8·0	816 0
" 2	12·6 X 8·6	106 3	8·0	830·0
" 3	12·6 X 10 0	125·6	8 0	1000 0
L	3 3 X 3·0	9·6	8 0	76 - 0
W	4 0 X 3·0	12·0	8 3	96 - 0
FUEL	4 0 X 3·0	12 0	8·0	96 - 0

TABLE OF AREAS.

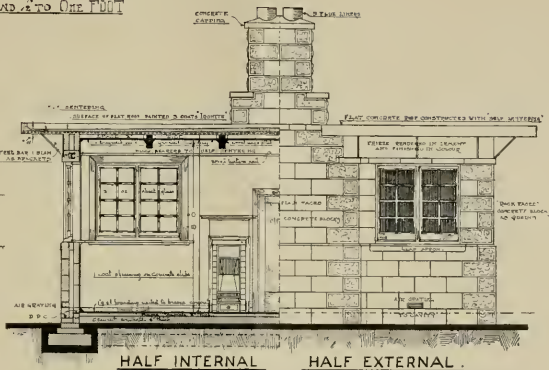


GROUND PLAN. ROOF PLAN.

SCALES ⅛ AND ¼ TO ONE FOOT

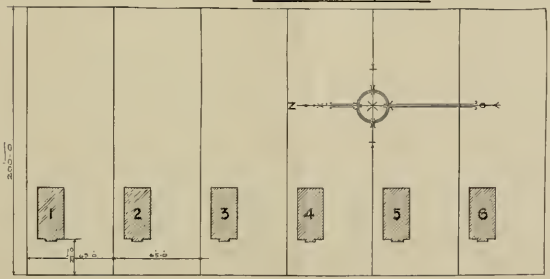
CUBIC CONTENTS

LENGTH 35·6
WIDTH 30 0
HEIGHT 1' 6
8130 0 C.FT



HALF INTERNAL HALF EXTERNAL.

WEST ELEVATION.



SITE PLAN

50·0 EQUAL ONE INCH

FIG. 90.—DESIGN NO. 206. BY ERNEST S. THOMPSON.

shows very slightly above the parapet ; " Hyrib " is used in the reinforcement of the concrete, in combination with a limited use of bars. The design is suitable for building in blocks of four in a row ; a black tarred skirting protects the lower portion of the external walls from wet and damp, and would be effective in execution.

The total cube of the two is 14,718 ft., and the estimated cost is £245 6s. at 4d. per cub. ft.

One of the prizes of 10 guineas goes to design No. 205, which is bracketted with No. 56. No. 205 is the only one of the premiated designs in which an approximately square plan is adopted for a block of two cottages, the living room being in front, with the scullery, fuel larder, and w.c. at the rear, with three bedrooms on the first floor. The living room is 156 ft. in area, the scullery 61 ft. in area, and the three bedrooms 135 ft., 80 ft., and 50 ft. in area respectively. The kitchen and scullery are 8 ft. 3 in. in height, and the bedrooms on the first floor are 8 ft. in height. A good feature in the bedrooms is that the windows are high up and close to the ceiling, so leaving no space for stagnant air above the window heads. The design is simple, depending on raised bands and panels for effect, which give the exterior a somewhat monumental character. The roof is of concrete hipped all round, and there is a suspended ceiling which may be considered one of the items of luxury in the design ; the fireplaces are cleverly arranged in the centre of the block, and the flues carried up in one stack for the pair of cottages.

The design is suitable for erecting in pairs, not in rows. The total cube for a pair is 14,555 ft., and the estimated cost £242 12s. for the two at 4d. per cub. ft. Design No. 56 is bracketted with No. 205, both receiving prizes of 10 guineas.

This scheme shows a block of two cottages with two bedrooms to each cottage on the first floor, which is entirely in a mansard roof, constructed of concrete. The balconies to the first floor windows might well be omitted as being both unnecessary and unsuitable in houses of this class. If a part of the money saved on the omission of these was to be spent on a raised block to support the water butts it would be appreciated by the occupier. A water butt is a convenience, and much more so when it is placed so that a bucket can be put under the wooden tap in general use. The same remark applies to Nos. 193 and 205.

All these competing gentlemen should recollect in future that water butts are for use more than for ornament and cease to be a pleasing feature in the design when they become old, in want of paint, and probably with a fungoid growth as an architectural dressing.

SPECIFICATIONS TO COMPETITION DESIGNS.

With Design No. 206. (By Ernest S. Thompson, Architect, 5, Victoria Street, S.W.)

In accordance with the published conditions,I have pleasure in submitting herewith a sheet of drawings, illustrating a cottage which provides all the accommodation asked for is economically planned, sound, cheap and substantial ; is one storey high, with a minimum use of timber, has good square rooms and no dark corners. Each cottage is detached, and is placed on the site so that every living room gets the full benefit of a southerly aspect. The bedrooms also are lighted with due consideration.

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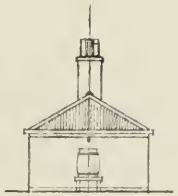
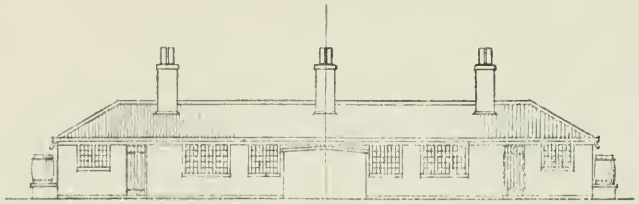
In accordance with the published conditions, I have pleasure in submitting herewith a sheet of drawings, illustrating a cottage which provides all the accommodation asked for is economically planned, sound, cheap and substantial ; is one storey high, with a minimum use of timber, has good square rooms and no dark corners. Each cottage is detached, and is placed on the site so that every living room gets the full benefit of a southerly aspect. The bedrooms also are lighted with due consideration.

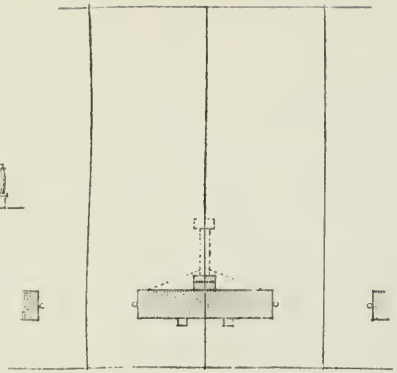
CONCRETE COTTAGE COMPETITION



END



BACK ELEVATION



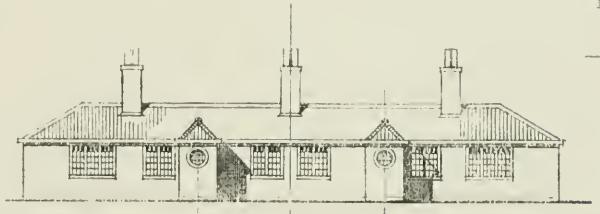
MAIN ROAD

TABLE

ROOM	SIZE	SUP.	HEIGHT	CUBE
E	4'+3½	15·9	7½	119
K.P.	14×11	154	9 (AV.)	1386
SC.	9½×7½	71½	"	400½
B	14×9	126	9	1134
B	10·6½	68½	"	616½
B	10×10	68½	"	616½
L	4×4½	18½	"	166½

CUBIC CONTENTS
14,362 C.FT.

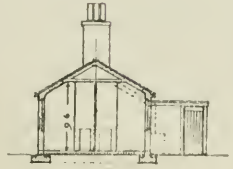
SECTION A-A



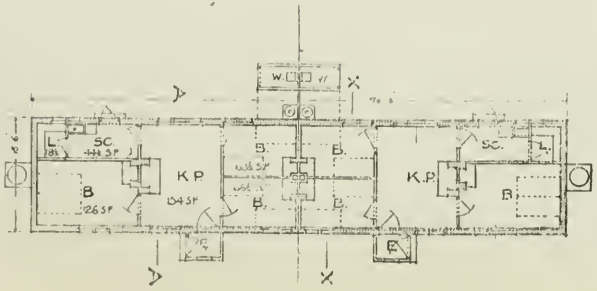
FRONT ELEVATION

SITE PLAN

½ INCH SCALE DETAILS



SECTION X-X



GROUND FLOOR PLAN

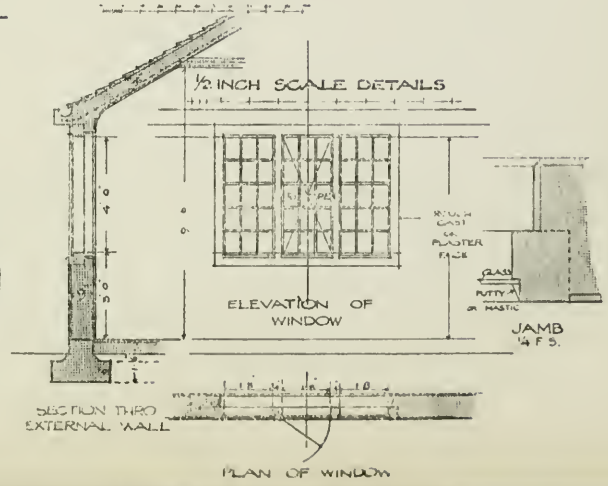


FIG. 91. DESIGN NO. 75. BY CHAS. BULMAN PEARSON, LICENTIATE, R.I.B.A.

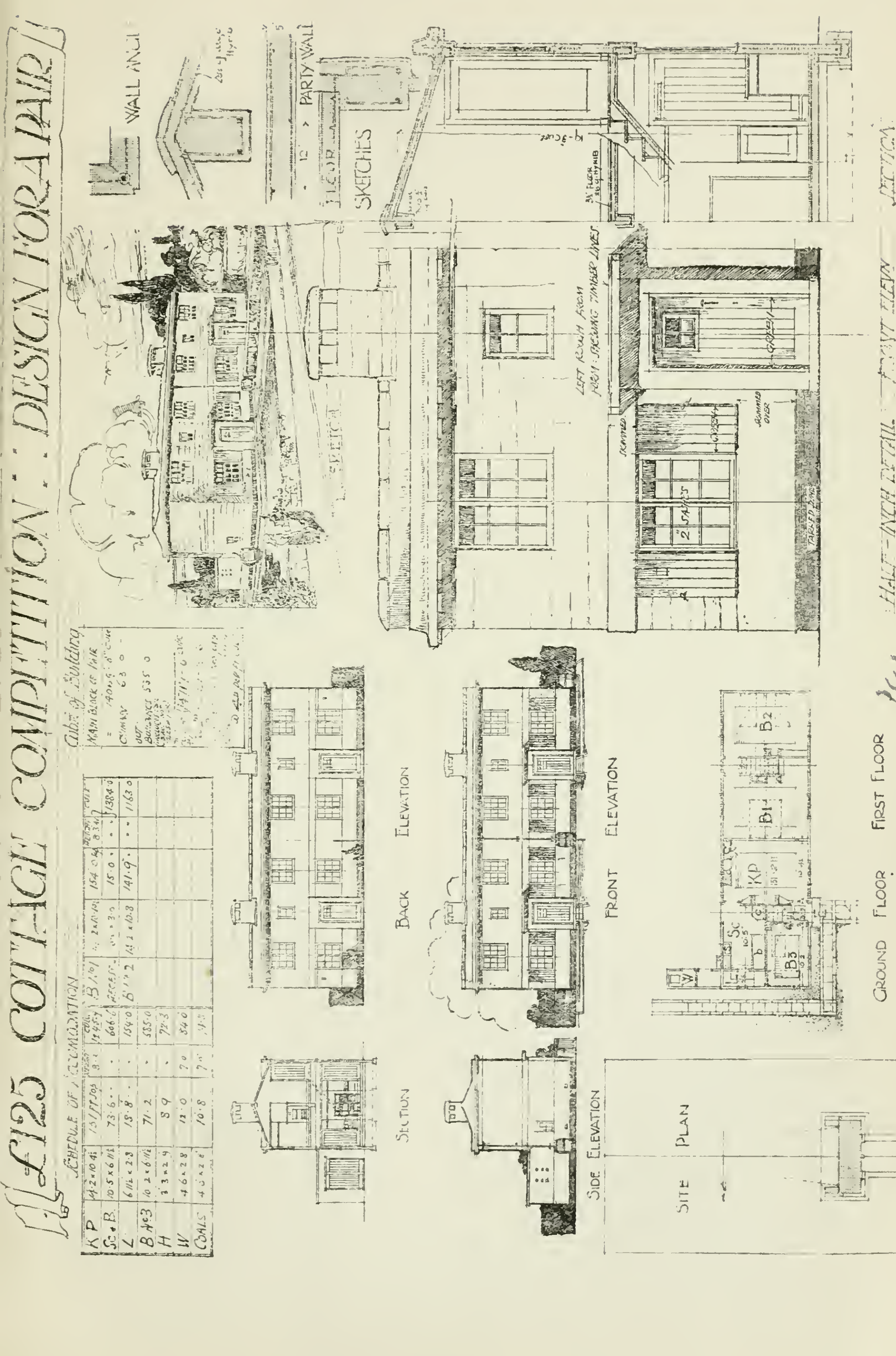


Fig. 92. Design No. 103. By Harold G. Holt, A.R.I.B.A.

CONCRETE COTTAGE COMPETITION

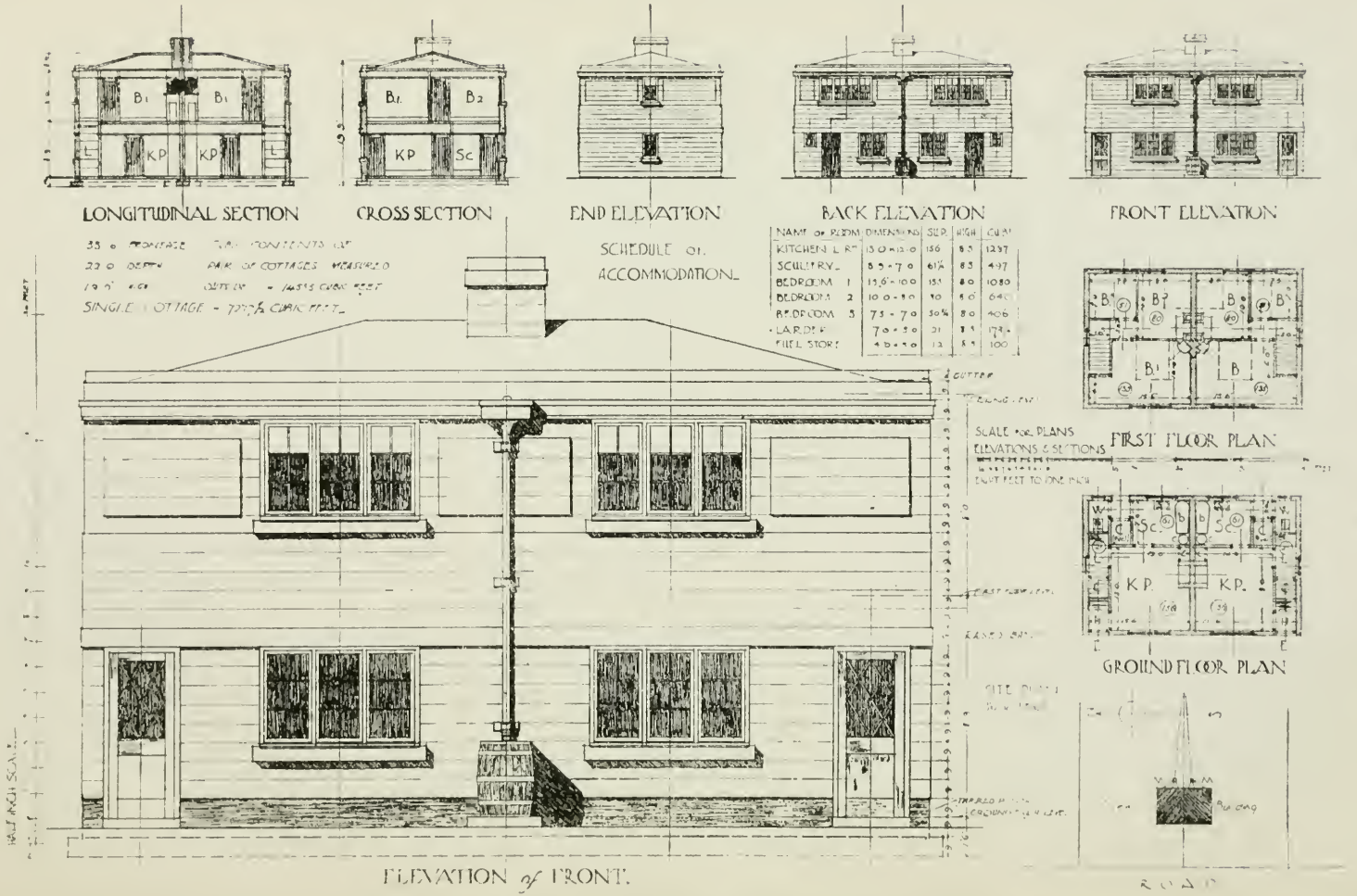


FIG. 93. DESIGN NO. 205. BY LEONARD G. HANNAFORD.

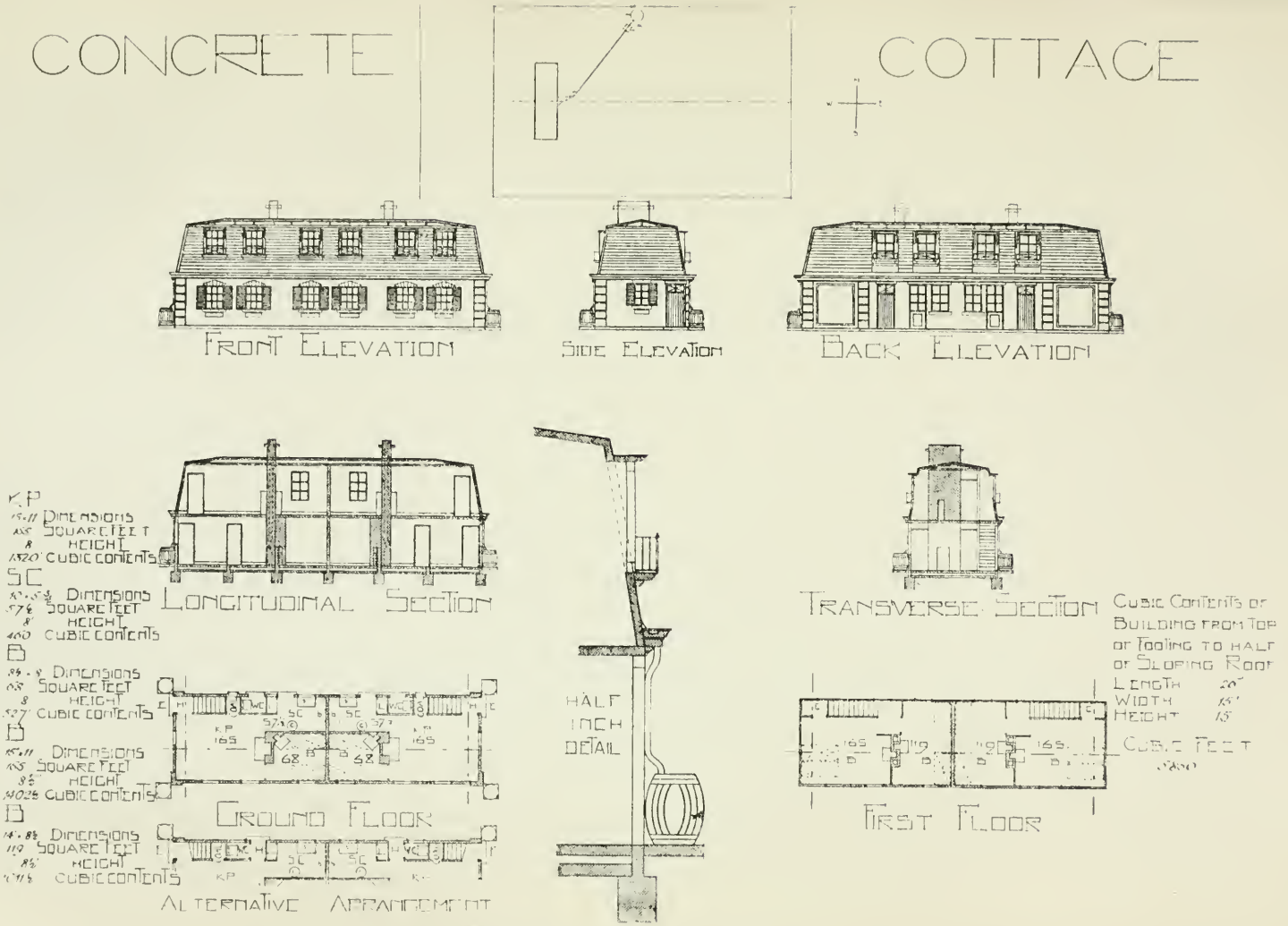


FIG. 94. < DESIGN NO. 56. BY M. CROSNIER.

The external walls are of 4½ in. solid concrete blocks and breeze concrete partition slabs 2½ in. thick, with a 2-in. cavity in between, well tied together. These slabs would also be used for the partition walls.

The external treatment is extremely simple, depending more for effect upon proportion and shadow, than the use of architectural adornment.

The floors of bedrooms are covered with 1-in. grooved and tongued boarding, nailed direct to the breeze concrete.

The other floors would be finished in granolithic or concrete tiles.

All internal surfaces of walls would be skimmed one coat, the boarded ceiling stained and varnished.

The drawings will be found quite explanatory of all other necessary points.

Specification.

Excavator.—Excavate site to a depth of 12 in.

Excavate for drains.

Provide and lay concrete beds under footings of external walls 2 ft. by 6 in. thick, composed of 1 part Portland cement to 6 parts of approved pit gravel, not exceeding 1½ in. gauge, with sufficient sand to fill the interstices.

Concretor.—Provide and lay concrete bed 4 in. thick, composed as before, under the surface of all floors.

The floors to the three bedrooms to be finished with 2 in. of fine coke breeze cement; the remaining floors with floated granolithic surfaces. All steps to be in concrete; ditto hearths.

Lintels to windows and doors to be in concrete, reinforced with steel joists or bars, as may be deemed necessary.

The quoins to all external angles of walls to have rock-faced surfaces, the remaining blocks of walling to be plain-faced.

The plinth to be finished with chamfered course, as shown on detail.

The remaining walls internally, such as fireplace openings, etc., to be formed with concrete bricks; the fireplaces to have fireclay brick linings.

Chimney cap to be plain, splayed and throated, and the crow-steps to chimney on west elevation to be plain 3-in. slabs, weathered and throated.

The concrete flat to roof to be formed of an average thickness of 3½ in., with a surrounding kerb and one outlet to rain-water pipe.

"Self-centering" has been adopted, with a view to economy and efficiency, and to obviate the use of temporary wooden shuttering.

Provide and coat the external surface flat roof with three coats of Ironite waterproofing compound.

Carpenter and Joiner.—The timber for all joiner's work to be best quality yellow deal, with the exception of the ceiling boarding, which will be grooved, tongued and beaded match-boarding, in narrow widths.

Door and window furniture to be of a substantial character.

Plasterer.—The whole of the internal surfaces of the walls to have one coat of skimming, with the exception of the fuel store and W.C., which would be lime-washed.

Plumber, Painter and Glazier.—Plumbing work to be of the best character. All glass to windows 21-oz. sheet.

All external and internal woodwork and ironwork to be painted three coats best oil paint, in addition to stopping and priming.

List of Fittings, &c.

		£	s.	d.
Kitchen Range	p.c.	4	10	0
Fireplaces and Mantels	,,	3	0	0
Sink	,,	1	0	0
Shelving	,,	2	10	0
Door Furniture	,,	2	10	0
Windows, ditto	,,	2	0	0

Statement of Cost.

To arrive at a fairly approximate estimate of the cost, I have taken out a bill of quantities, which I have priced upon established figures, with a due regard to the conditions stated, viz., the buildings are to be erected by the employer's own labour, without the introduction of a third party, and that no main drainage, or gas or water supply, or any plumbing or sanitary work, or equipment other than a length of 40 ft. of 4-in. drain is required, and I beg to append a summary thus obtained of the cost of each trade, inclusive of all fittings :—

	£	s.	d.	£	s.	d.
Excavator and Drainer				4	0	0
Concretor :						
Walling	35	0	0			
Foundations	15	0	0			
Roof	25	0	0			
Floors	5	0	0			
				80	0	0
Joiner :						
Windows	10	0	0			
Doors	10	0	0			
Ceiling	10	0	0			
Floors	3	10	0			
				33	10	0
Plumber, Painter and Glazier				8	0	0
				£125	10	0

With Design No. 75. (By Chas. Bulman Pearson, Licentiate R.I.B.A., 109, High Road, Chiswick, W.)

Description and Remarks.—The author has endeavoured to carry out the conditions of the Competition. The areas of the rooms have been closely adhered to and the accommodation provided is, in his opinion, consistent with cost.

Concrete to be used wherever possible and the amount of woodwork reduced to a minimum. This being necessary in the case of doors, cupboards, etc.

It is proposed that the floors and roof be of concrete, the floor surfaces to be finished with a patent composition such as " Doloment " or other approved method.

The roofs to be covered with approved concrete tiles. If not contrary to the spirit of the Competition, it is suggested that a good coloured red tile would form a very fine contrast to the other portions of the buildings.

The walls and chimney stacks to be in concrete built *in situ*, the interior partitions to be in slab concrete. The external faces of the walls, where shown on drawings, to be finished in plaster or rough cast trowelled smooth.

All woodwork has been eliminated from windows, the method proposed being shown on the details.

With Design No. 193. (By Harold G. Holt, A.R.I.B.A., 11, Probyn Road, Wallasey, Cheshire.)

The cottages shown on the accompanying drawing have been designed in accordance with the conditions, and with a view to strict economy, combined, so far as possible, with a reasonably pleasing appearance, suitable for rural districts. The author has made an effort to get away from the somewhat box-like appearance which follows a flat roof treatment in a small building.

Standardisation.—In planning the cottage the view was to repeat the parts as much as possible. On consideration the author decided that to merely design a cottage suitable for

brickwork, timber and slated roof, and label it "concrete block cottage," though allowable under the conditions, was not advancing the purpose of the Competition very far, and made an effort to design a cottage where repetition of parts would enable it to be economically built, with outside walls, etc., of concrete moulded horizontally.

The accommodation shown complies with the conditions, and is substantially that reported as desirable by the Departmental Committee, which investigated the Small Holders' housing question.

Through ventilation is obtained in the best rooms and staircase. Owing to the low thermal conductivity of concrete, the cottage would be cool in summer and warm in winter. Water-tightness obtained by careful grading, etc., and oil-mixed finish suggested if in wet locality.

With Design No. 205. (By Leonard G. Hannaford, 42, Rock Park, Rock Ferry, Cheshire.)

The author has designed the cottages with a view to absolute economy in administration, as well as of construction and upkeep, the accommodation being within a rectangle without any outbuildings. The fireplaces are grouped together so as to form one central stack serving the pair of cottages.

As well as a large kitchen-living room there is a scullery fitted with copper, bath and sink, a fuel store well placed, and large larder, and cupboard for food.

The staircase is convenient and easy; the upstairs landing is reduced to a minimum, which gives all available space to the bedrooms.

The position of the W.C. is at the rear of the cottage, and entered from the back porch, and the whole of the plumbing and drainage work is compact and therefore inexpensive.

The general treatment is of a symmetrical and simple character, and an endeavour has been made to make the elevations quiet and pleasing in effect.

With Design No. 56. (By M. Crosnier, 20, Brechin Place, Kensington, S.W.)

Description of the Building.—In the accompanying design the cottages are arranged in semi-detached blocks. The entrance doorway, placed in a lobby formed in the side elevation, gives immediate access to the staircase leading to the rooms on the upper floor and indirect access to the well-lighted combined living room and kitchen (15 ft. by 11 ft.), containing a floor area of 165 ft. This room forms the approach to bedroom (8 ft. 6 in. by 8 ft.), containing a floor area of 68 ft. and suitably arranged for two beds; and to the scullery (10 ft. by 5 ft. 9 in.), which has a floor area of over 57 ft., and is fitted with a copper, sink and bath, the latter being sunk below the level of the floor and covered with a hinged top to close flush with the floor when the bath is not in use.

The coal store, accessible both externally and internally, is placed under the stairs, and the larder is entered from the scullery; but, for sanitary reasons, the W.C. entrance is external (see description of the alternative arrangement).

There are two spacious bedrooms upon the first floor, the larger of which (15 ft. by 11 ft.) has a floor area of 165 ft., and the smaller (14 ft. by 8 ft. 6 in.) one of 119 ft. Each bedroom is planned for two beds, the larger room is fitted with a spacious cupboard, and all three bedrooms have fireplaces.

A simple architectural treatment, consistent with the limitations of the cost of the proposed building, has been adopted, and it is hoped that the quoined concrete walls and boldly moulded cornice, in combination with the red concrete tiles of the mansard roof with its balconettes for flowers, and the green shuttered lower windows, will tend to produce a simple and homelike effect.

Alternative Arrangements.—An alternative arrangement is shown upon the drawing under which there is no direct external entrance to the scullery, and the W.C. is entered under cover from the adjoining lobby. This arrangement makes the scullery less cramped for working purposes.

REFERENCES ON DRAWINGS.

B	..	Bedroom.	m	..	Manhole.
Bt	..	Bathroom (if any).	E	..	Main entrance.
L	..	Larder or food store (if any).	H	..	Hall, lobby or ante room (if any).
C	..	Cupboard or closet (if any).	K	..	Kitchen.
W	..	W.C.	P	..	Living-room or parlour (if any).
d	..	Dresser (if any).	KP	..	Combined living-room and ktchen (if any).
c	..	Copper (if any).			
s	..	Sink.	Sc	..	Scullery or wash house (if any).
b	..	Bath (if any).			

Design No. 248 is a one-storey cottage with a flat concrete roof, with an original plan, and was thought worthy of one of the consolation prizes of £5 5s.

The diagonal treatment with the re-entering angle, in which the door is placed, is not economical, and leads to waste on the plan in the length of the passage ; otherwise the arrangement is good and might suit the views of some to whom cost is not the first consideration, and the aspect of the windows is excellent.

The living room is 156 ft. in area, the scullery 67 ft. in area, and the three bedrooms 142 ft., 109 ft. and 82 ft. in area respectively, all 8 ft. high. A good store, receptacle for fuel, and W.C. are all provided under the roof of the main building. The cube is given as 8,538 ft., which is the largest amongst the selected designs, and the price, 3½d. per cubic foot, is below what the work might be expected to be carried out for. At this price the cost would be £125.

Another design which comes in for a consolation prize is No. 129, constructed entirely of concrete. A two-storey pair of cottages, the pair to stand isolated, each having a living room, scullery and bedroom on the ground floor, and two bedrooms on the first floor. The food cupboard is in the house, but the fuel store and W.C. are in a small projecting wing at the back.

The living room is 148½ ft. in area, the scullery 60 ft. in area, and the ground-floor bedroom 66½ ft. in area. One bedroom on the first floor is 140 ft. and the other 107½ ft. in area. There are two cupboards entered from one of the bedrooms, which is a very great convenience in a house of this description. As a rule accommodation for clothing is conspicuous by its absence.

The ground-floor rooms are about 8 ft. 2 in. high, and those on the first floor 8 ft. 6 in. high. The cube for the pair is given as 14,090 ft., and the estimated cost is £249 9s. 3d., this being about 4¼d. per ft. cube.

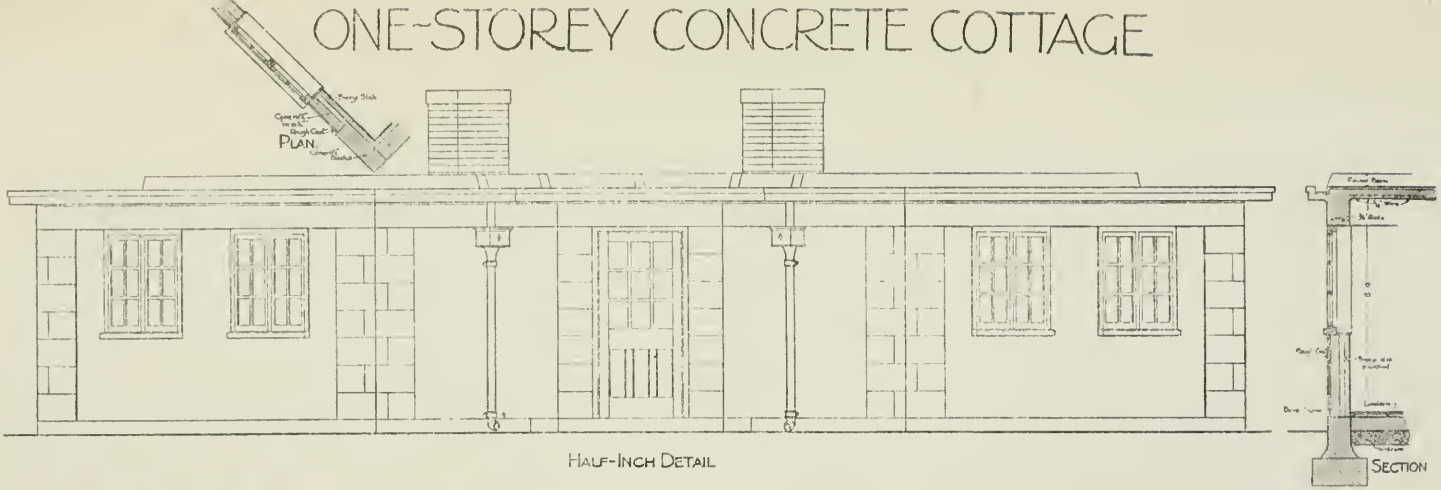
GENERAL DESCRIPTION.

With Design No. 248. (By E. W. Stubbs, A.R.I.B.A., Grayshott, Marlborough Road, South Croydon.)

This cottage has been designed to provide a compact and convenient plan with the minimum of waste space, while retaining an ample amount of light and a suitable aspect in all the rooms.

The one-storey plan gives the maximum of floor space in proportion to the amount of external wall, and has the advantage of saving the space occupied by the stairs.

ONE-STOREY CONCRETE COTTAGE

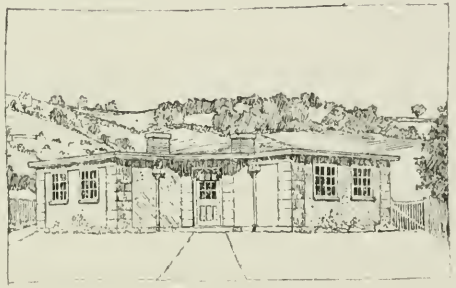



WEST ELEVATION


SECTION AA


S.E. ELEVATION

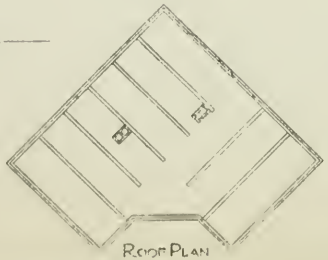

N.E. ELEVATION


PERSPECTIVE SKETCH.

SITE PLAN
32 FEET TO 1 INCH

8 FEET TO 1 INCH

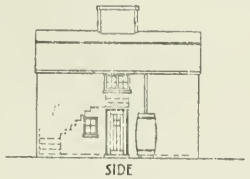
FLOOR PLAN

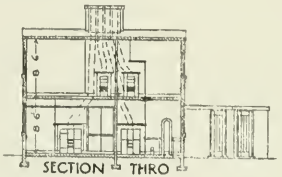

ROOF PLAN

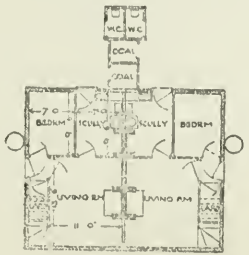
ROOM	REF.	LENGTH	BREADTH	AREA	HEIGHT	CONTENTS
LIVING RM.	K.P	14'-0"	11'-0" av.	156ft sup	8'-0"	1248 ft cu
SCULLERY	Sc	9'-0"	7'-6"	67 "	8'-0"	536 " "
BED ROOM	B1	15'-0"	9'-0"	142 " "	8'-0"	1136 " "
BED ROOM	B2	12'-6" av.	8'-6"	109 " "	8'-0"	872 " "
BED ROOM	B3	11'-6" av.	7'-0"	82 " "	8'-0"	656 " "

CUBIC CONTENTS =
116 (31'-0" + 13'-6") × 17'-6" = 8538 ft cu
@ 3½d = £125

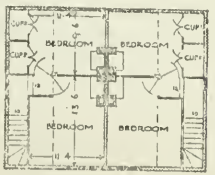
FIG. 95. DESIGN NO. 248. BY E. W. STUBBS, A.R.I.B.A.





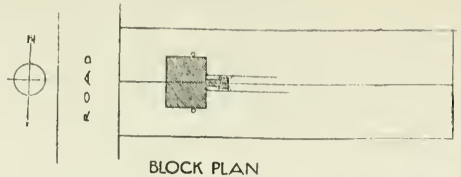


GROUND FLOOR



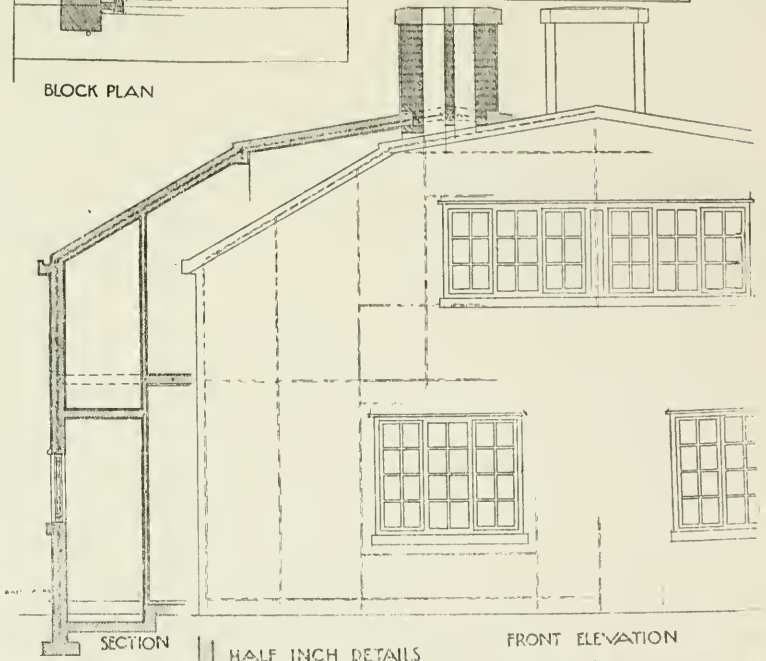
FIRST FLOOR

SEMI-DETACHED PAIR OF COTTAGES



BLOCK PLAN

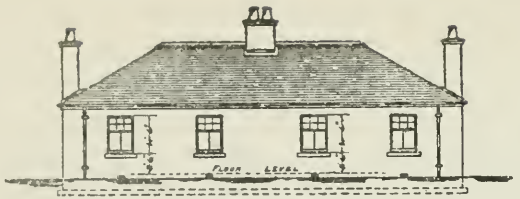
CUBIC CONTENTS PER PAIR 14090 CU FEET @ 4½ = [249·9 s



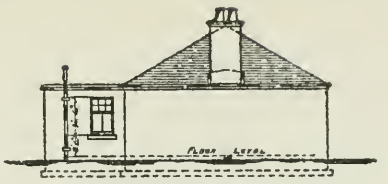
NOTE EXTERNAL WALLS & ROOF CONCRETE REINFORCED WITH STEEL BARS, ALSO FLOORS PER INSIDE PORTION OF PARTY WALL, STAIRS & STEPS. THE CONCRETE ROOF TO BE COATED WITH PITCH AND THE VOIDS FILLED WITH FINE STAR CHIPPINGS AS THE ROOFS HAVE A SLOPE FOR RAINWATER, RUNS AWAY QUICKLY, THIS TREATMENT WILL ENSURE A WATERTIGHT COVERING. THE FIRE PLACES ON BOTH FLOORS TO BE IN BRICKWORK & OTHERWISE LINED, THE CHIMNEY STACK TO BE IN BRICKWORK SKIMMED EXTERNALLY WITH CEMENT & HAVING A CONCRETE CAPPING ON TOP.

THE INTERNAL WALLS OR PARTITIONS TO BE OF EXPANDED METAL SLAB PARTITIONS REINFORCED WITH RODS. THE W.C'S AND COALPLACES AT THE BACK TO HAVE ARTIFICIAL CONCRETE ROOF TREATED AS DESCRIBED ABOVE. DOORS AND FRAMES WINDOW FRAMES TO BE OF RED DEAL PAINTED. ALL FLOORS WITH THE EXCEPTION OF LIVING ROOM WHICH IS FINISHED WITH WOOD BLOCKS TO HAVE 1" GRANOLITHIC FINISH. THE STAIRS TO BE SIMILARLY FINISHED AND WITH SOUND 3" NOSINGS TO TREADS. SINKS WASH BOILER TOP & BOTTOM GUTTERS, CAST IN CONCRETE. BOTTOM WALLS TO BE HOOP CAST IN SITU.

FIG. 96.—DESIGN NO. 129. BY MESSRS. COCKER AND HILL, A.A.R.I.B.A

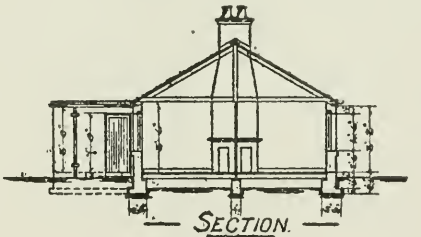


— BACK ELEVATION. —

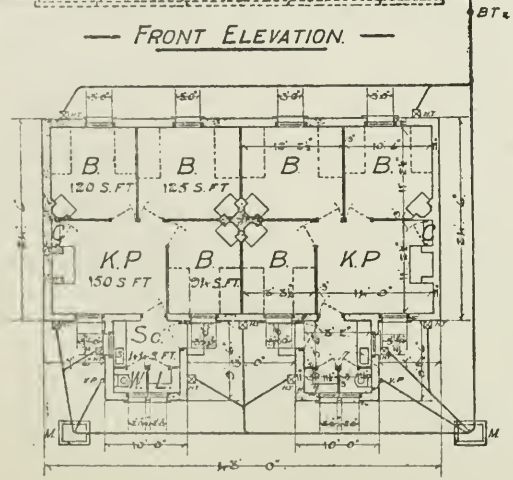


— SIDE ELEVATION. —

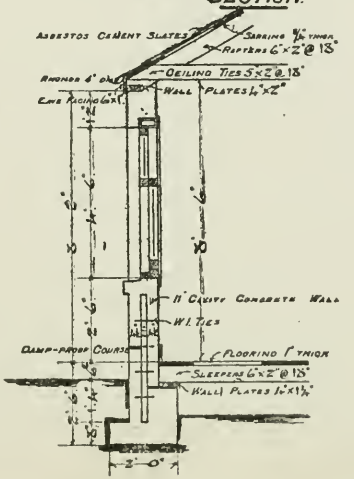
— FRONT ELEVATION. —



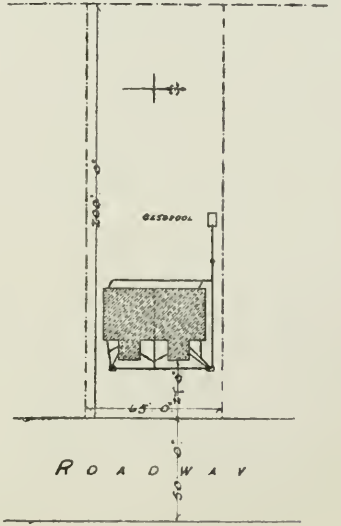
— SECTION. —



— GROUND FLOOR PLAN. —



LIST OF ROOMS IN ONE COTTAGE.				
ROOMS	DIMENSIONS	SUPER. AREA	HEIGHT	CUBIC CONTENTS
K.P	11'0" × 11.2½'	130'	8'6"	1275'
Sc	8'2" × 8'6"	44'	8'0"	352'
B	12'2½ × 11.2½'	125'	8'6"	1062½
B.	11.2½ × 10'6"	120'	8'6"	1020'
B.	11.2½ × 8.8½	94'	8'6"	799
L.	5'11½ × 2'10"	11'	8'0"	88'
C	3'0" × 1'0"	3'	7'0"	21
W.	3'11½ × 2'10"	11'	8'0"	88'
CUBIC CONTENTS OF ONE COTTAGE 9960 FEET.				



— SITE PLAN. —

SCALE FOR SITE PLAN ½" = 1 FOOT

10 5 0 10 20 30 40 50 FEET.

0 10 20 30 40 50 100 150 FEET.

FIG. 97.—DESIGN NO. 16. BY J. A. SMITH.

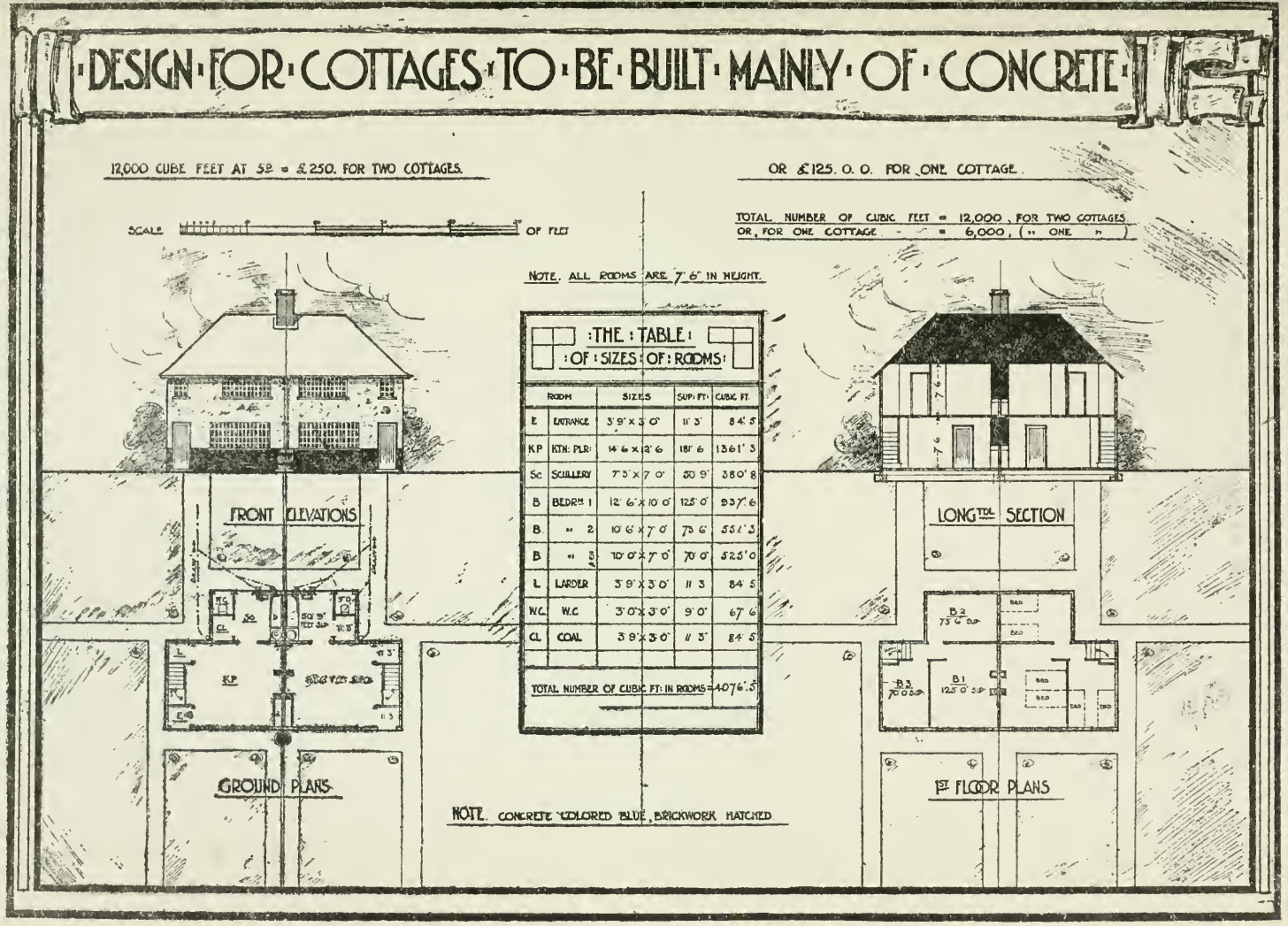


FIG. 98.—DESIGN NO. 53. BY HORACE JONES.

The outer walls are to be built with panels of *in situ* concrete, the piers shown being first built with concrete blocks and serving as a support for the necessary shuttering.

The panels are afterwards to be finished with rough cast externally, and to prevent condensation the internal face of wall is to be lined with 2-in. breeze concrete slabs finished with a setting coat of plaster, leaving a 2-in. cavity as shown.

The roof is to be of concrete with beams on the upper surface, and is to be finished with cement rendering waterproofed with "Pudlo." The reinforced lintels are to be continued round the whole building, and the roof is to overhang the entrance to form a shelter.

Access to the W.C. and fuel store is by a covered lobby. The two chimneys required are to be of brick, the fireplaces being all arranged on internal walls to avoid loss of heat.

The flues are to have slabs of concrete as shown over the fireplace openings to prevent down-draught.

Excellent bedroom accommodation has been made a feature of the plan, the areas shown being the actual floor areas exclusive of chimney breasts, cupboards, etc.

With Design No. 129. (By Messrs. Cocker and Hill, A.A.R.I.B.A., 20, Station Buildings, Altrincham.)

Description of Design.—The plan is so arranged that there is very little traffic through the living room, and a maximum of bedroom space upstairs.

The coal-places and W.C.'s are placed together, so that as little of the back garden space is taken up as possible.

The external walling is straight and simple, so that it may be quickly and easily built. The concrete roof is in flat, simple surfaces and slightly sloped, so that the water may get quickly away. This treatment helps to do away with the box effect associated with a flat roof on a plan of this kind.

External walls and roofs, floors and piers inside, to be Portland cement concrete reinforced with steel bars. The internal walls and partitions are of patent cement slabs, and are joined to the walls, etc. The roof to be covered with pitch and tar, and dusted with fine spar.

The surface of the external walls to be dinged, or rough cast and dinged.

The windows and doors, and frames to same, to be red deal painted.

With Design No. 16. (By J. A. Smith, the Highland Railway Engineers' Department, Inverness.)

This design is suitable for detached or semi-detached labourers' cottages, or it could be built in blocks of four or more, as the occasion required. The cottages are to be built of concrete, the walls being 11 in. thick cavity walls, rock-faced and cement pointed on the outside, the partitions being of concrete slabs 2 in. thick and with plaster applied directly on the inside of the concrete walls and both sides of the partitions, the mains roofs being slated with grey asbestos cement slates with concrete ridging, the roofs of scullery wings being of concrete 4 in. thick. The cills, lintels, hearths, door platts, chimney stalks and coping, and floors of sculleries, larders and W.C.'s, being all of concrete.

With Design No. 53. (By Horace Jones, 7, Berwick Street, Eccleston Square, S.W.)

The cottages are intended to be built of concrete, finished with cement and "Pudlo," and the roofs to be covered with "Eternit" red tiles.

From the ground line to top of ground floor window cills will be twice tarred.

The windows to be casements in solid frames, part fixed and part hung, and divided up into small squares.

Doors to be framed, ledged and braced, or ledged doors.

The chimney breasts and stack to be built in brickwork.

Painting to be three-coat work.

Realising that there cannot be much scope for decoration and originality of design for the money to be spent, the author has endeavoured to rely on simplicity to make the cottages effective.

With Design No. 105. (By S. Walton, Buxton, Derbyshire.)

Description of the Building.—The accompanying design illustrates a proposed detached cottage to be erected in a series of six.

It is proposed to place the building anglewise on the plot to give the living-room the maximum of sunlight.

The accommodation is provided on one floor on account of economy and compactness, and comprises front and back (indirect) entrances, hall or passage, combined living-room and kitchen, scullery, bathroom, larder, W.C., principal bedroom (adults'), and two bedrooms (male and female children).

The block plan shows suggested position of a coal and tool store and yard, but the provision of these is not included in the total cost ; they would probably be wood structures provided by tenant.

The required floor areas of principal rooms are provided, and the plan is compact without being cramped. All rooms are 8 ft. 6 in. high from floor to ceiling.

A ½-in. scale detail is given showing the proposed treatment of walls, floors, foundations, roofs, joinery, etc.

A perspective sketch taken at a point 100 ft. from the front angle of the building is also given.

The proposed drainage is shown on the ground and block plans.

With Design No. 162. (By W. A. Keates, 5, Little George Street, Westminster, S.W.)

These cottages are designed to meet the requirements of rural working men, after many years' experience in designing cottages on various estates about the country. As a rule, the rooms in cottages are too small, and the parlour generally provided, in my opinion, is almost useless except as a bedroom. In the design submitted a large living-room is provided, approached by a lobby entrance, and is fitted with cupboard and dresser, and larder under stairs ; working kitchen in rear, fitted with copper and bath, the former supplying bath with hot water, the bath to have hinged cover, and there is a sanitary ware sink with cold water laid on. Cupboard for pots and pans and coal place, back lobby and W.C. The rain-water from back part of the cottage to be collected into an iron tank with tap. Over and partially in the roof there is a large bedroom in front and two smaller in rear—two with fireplaces. The small room to have 6-in. by 6-in. ventilator in ceiling and over door. As requested, the rooms have two beds in each in different positions. Concrete is intended to be used as far as practicable.

With Design No. 173. (By John H. Markham, 82, Radnor Road, Harrow.)

Concrete.—For foundations and under floors to be composed of 1 part of cement or good hydraulic lime to 5 parts of suitable aggregate. Under the floor slab a 4-in. layer of dry core or broken brick to be laid.

Damp Course.—To consist of bitumen sheeting.

Walling and Partitions.—To be formed, as shown, of 3-in. breeze concrete slabs set in cement. The outer wall to be in a double thickness, with a 3-in. cavity, the two shells to be connected by galvanised wrought-iron ties, at least two to each horizontal joint of each slab. The top of the wall to be finished with a slab laid flat, on which will rest the timber roof.

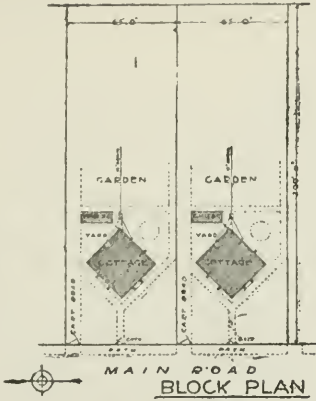
Cills and Steps.—To be of fine cast concrete or artificial stone.

Roof.—To be constructed of fir timber, as shown, covered with battens.

Flooring.—To be composed of splayed battens tarred and embedded in the concrete in all rooms, except scullery, larder, W.C., entrance to lobby and coals, and to be finished with 1-in. deal flooring in narrow widths.

In scullery, larder, W.C., entrance lobby and coal, the concrete to be finished with a ¾-in. cement floated face.

Roof Covering.—To be of asbestos cement slates of approved manufacture, laid with copper nails and clip, in accordance with makers' directions.



BLOCK PLAN

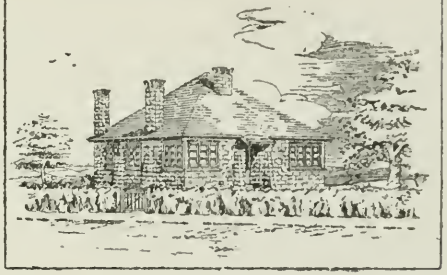
DESIGN FOR DETACHED COTTAGE

TABLE	DIMENSIONS	AREA	HEIGHT	CUBIC CONTENTS
LOBBY & HALL	3'.6" X 16'.3"	56'.10"	8'.6"	483'.0"
COMBINED LIVING ROOM & KITCHEN	13'.0" X 15'.0"	195'.0"		1657'.6"
SCULLERY	9'.3" X 6'.6"	60'.1"	"	510'.8"
BEDROOM (LARGE)	13'.3" X 10'.0"	132'.6"	"	1126'.3"
BEDROOMS (SMALL)	10'.0" X 9'.0"	90'.0"	"	765'.0"
BATHROOM	4'.0" X 9'.4"	37'.4"	"	317'.4"
LARDER	5'.6" X 2'.6"	13'.9"	"	116'.10"
W.C.	5'.6" X 3'.0"	16'.6"	"	140'.3"

CUBIC CONTENTS OF BUILDING 11756'.0" AT 2½°

COST £122.9.2.

PERSPECTIVE

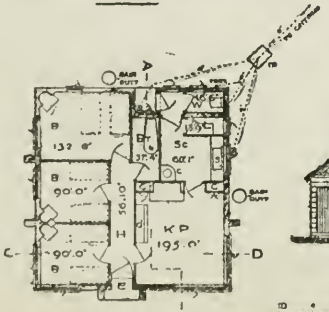


ELEVATIONS

S.W.

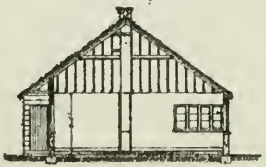
N.W.

N.E.



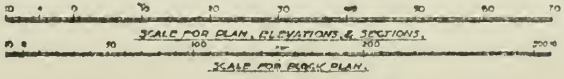
PLAN

SECTIONS

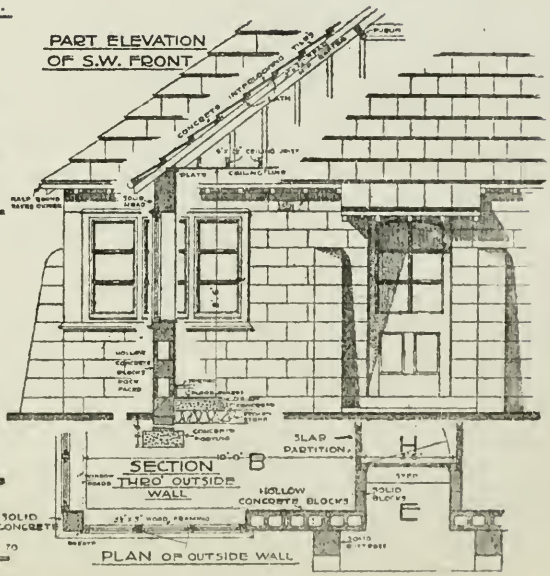


A.B.

C.D.



PART ELEVATION OF S.W. FRONT



A DETAIL

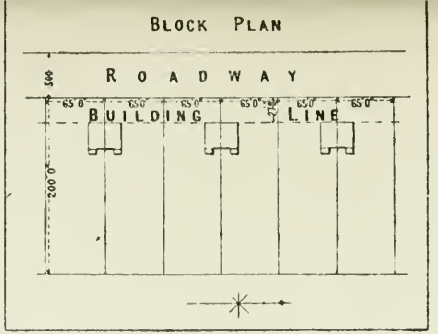
FIG. 99.—DESIGN NO. 105. BY S. WALTON

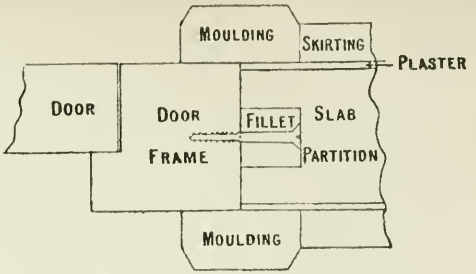
PAIR OF LABOURER'S COTTAGES.

THE CONCRETE AND CONSTRUCTIONAL ENGINEERING COMPETITION 1914.

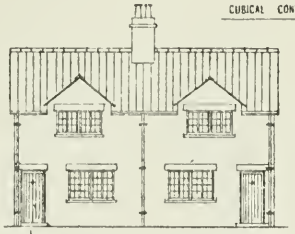
TABULATED PARTICULARS

	ROOMS	DIMENSIONS	HEIGHT	SUPERFICIAL AREA	CUBICAL CONTENTS
H	LOBBIES	4·0×3·6 / 4·6×3·6	8·0	29·9	238
K	WORKING KITCHENS	15·0×8·6	8·0	110·8	884
P	LIVING ROOM	16·0×13·0	8·0	208·0	1664
B	BEDROOM	14·6×12·6	7·6	179·0	1342
"	D°	12·0×8·0	7·6	96·0	720
"	D°	8·6×8·0	7·6	68·0	510

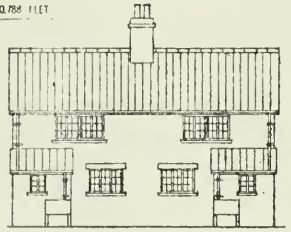




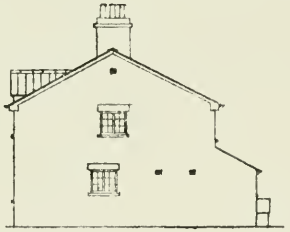
INNER DOOR FRAME FULL SIZE



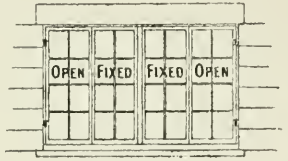
FRONT ELEVATION



BACK ELEVATION



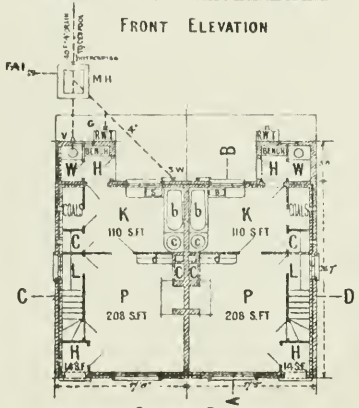
END ELEVATION



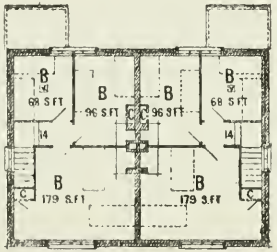
ELEVATION

WINDOW SECTION

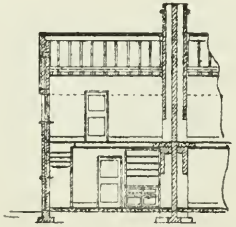
PLAN OF WINDOW



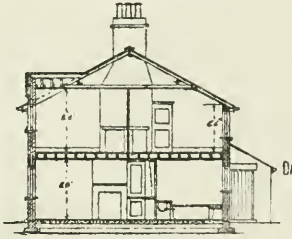
GROUND PLAN



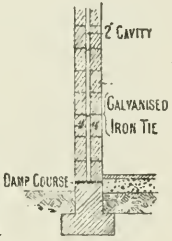
CHAMBER PLAN



SECTION C D



SECTION A B



DETAIL SECTION OF WALL

FIG. 100.—DESIGN NO. 162. BY W. A. KEATES

CONCRETE COTTAGE COMPETITION

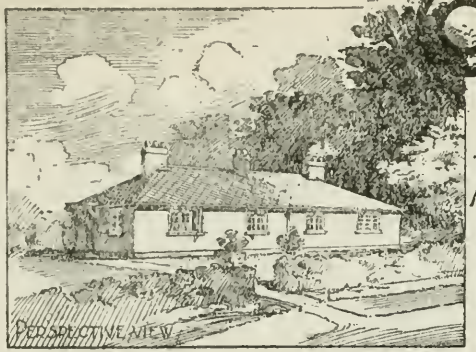
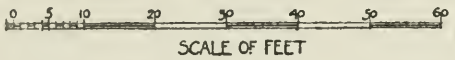


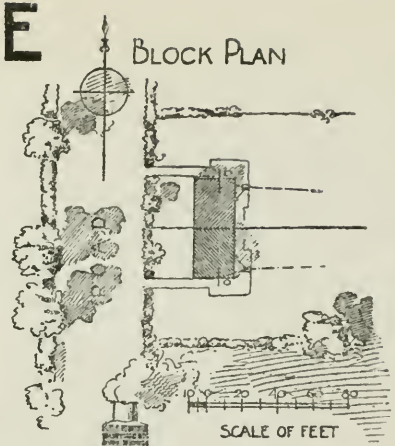
TABLE OF ACCOMMODATION

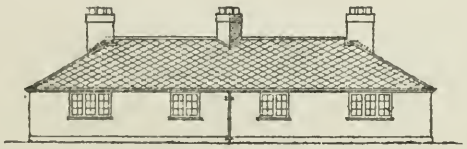
	DIMENSIONS	AREA	HEIGHT	CUBE	PLAN REF.
ENTRANCE LOBBY	3.3×3.0	9¾ FT.	8.0.	76 FT.	H
KITCHEN-LIVING RM	15.0×11 AVGE.	165 "	do.	1310 "	KP
SCULLERY	9.0×6.6"	58½ "	do.	464 "	Sc
BEDROOM 1	12.0"×10.6"	126 "	do.	1,000 "	B1
DO. 2	11.0×9.0"	99 "	do.	790 "	B2
DO. 3	9.6"×8.0"	76 "	do.	605 "	B3
STORE CUP^{BD}(C). FOOD CUP^{BD}(L). COALS (CIs). W.C.					

CUBIC CONTENTS OF ONE COTTAGE 8080 FEET



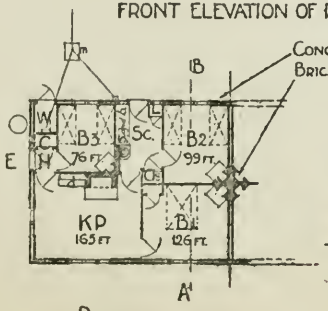
BLOCK PLAN



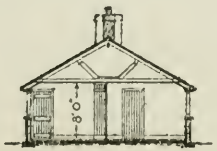


FRONT ELEVATION OF PAIR

BACK ELEVATION

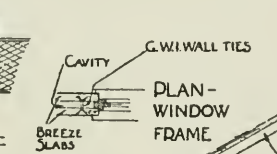


PLAN

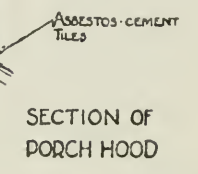


SECTION A-B

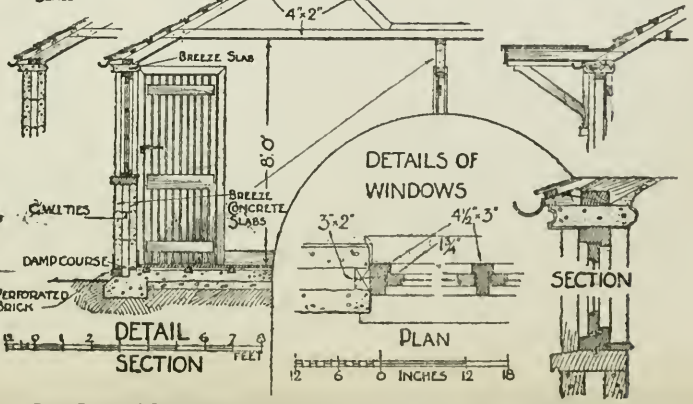
END ELEVATION



PLAN - WINDOW FRAME



SECTION OF PORCH HOOD



DETAIL SECTION

PLAN

SECTION

FIG. 101.—DESIGN NO. 173. BY JOHN MARKHAM.

£125 CONCRETE COTTAGE COMPETITION

CUBIC CONTENTS OF BUILDINGS

DETACHED 7188 - £125.

SEMI DETACHED 7740 - £125

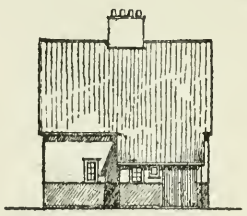
TABLE OF SIZES

	SIZES OF ROOM	AREA IN SQU FEET	HEIGHT	CUBICAL CONTENTS OF ROOMS		SIZES OF ROOM	AREA IN SQU FEET	HEIGHT	CUBICAL CONTENTS OF ROOMS
K P	14'x11'	154	8'0"	1232	B1	11'x11'	132	8'0"	1056
S C	11'6"x6'	69	8'0"	552	B2	11'x8'6"	93	8'0"	744
					B3	8'6"x8'	72	8'0"	576

FRONT ELEVATION OF DETACHED

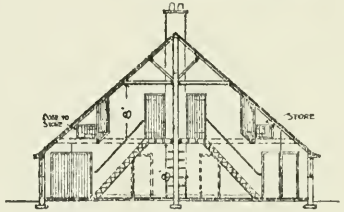
TYPE B

BACK ELEVATION

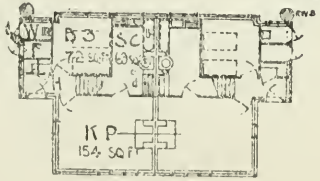


SIDE ELEVATION

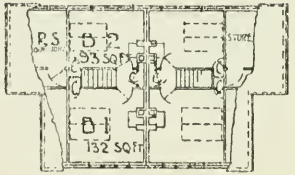
FRONT ELEVATION



SECTION 'A' 'A'

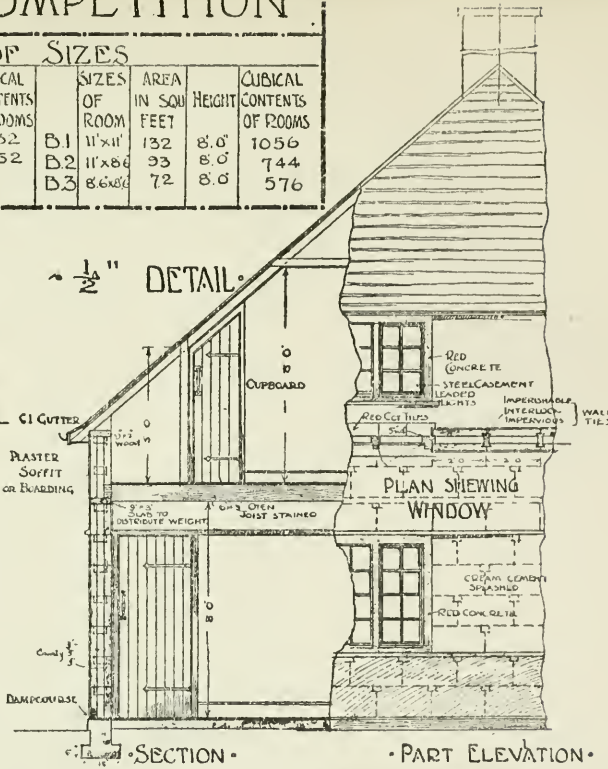


GROUND FLOOR



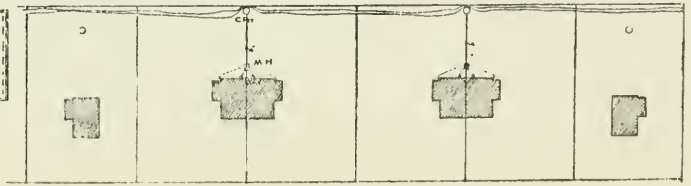
FIRST FLOOR

½" DETAIL



SECTION

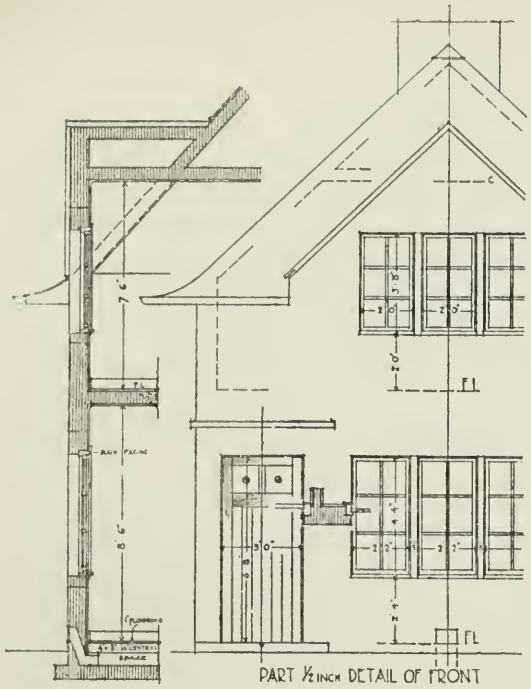
PART ELEVATION

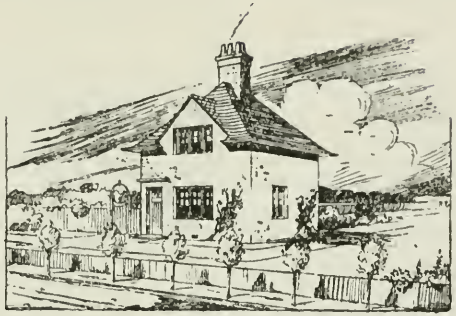


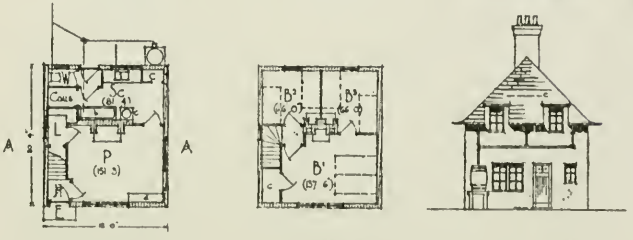
BLOCK PLAN

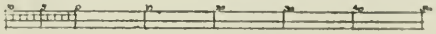
FIG. 102.—DESIGN NO. 229. BY G. E. CLARE, M.S.A.

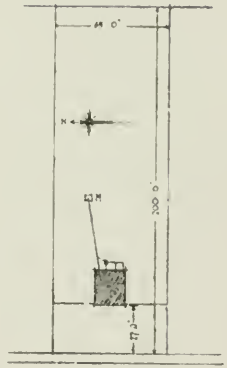
DESIGN FOR LABOURERS COTTAGE IN CONCRETE

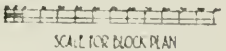












TABLE

H	3·9×5·0	11·5 AREA	8·6 HEIGHT	95·8 CUBICAL CONTENTS
P	13·9×11·0	151·5	8·6	1285 7
Sc	10·6×7·9	81·4	8·6	691 4
B^1	13·9×10·6	147·6	7·6 to ceiling	900 0
B^2	8·5×8·0	66·0	7·6	400 6
B^3	8·8×8·0	66·0	7·6	400 6
L	5·6×3·6	19·5	7·6 HEIGHT	149 4
Coals	4·0×8·0	17·0	8·6	102 0
c	3·0×3·9	5·8	8·6	44 7
W	4·0×2·6	10·0	8·6	85 0
Cpn.	5·0×2·8	15·4	5·6	75 4
				5102 0 TOTAL

TABLE

CUBICAL CONTENTS OF BUILDING

20 4 × 18 0 × 10·6

= 7508 CUBIC FEET

AT 4° = £125 0·0·

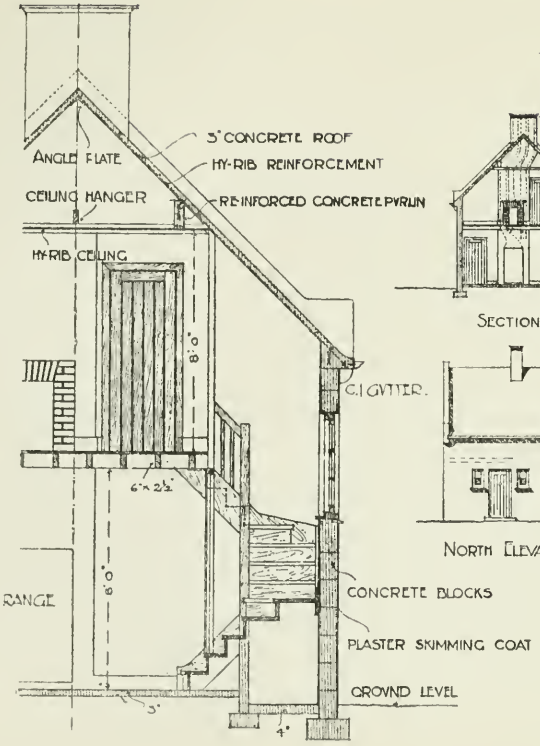
MEASURED FROM BOTTOM OF FOOTINGS TO HALF WAY ABOVE BED TO CEILINGS TO RIDGE

TABLE

FIG. 103.—DESIGN NO. 9. BY JOHN DALL.

CONCRETE COTTAGE COMPETITION

COST . 7950 CU FEET AT 3¾° = £125.



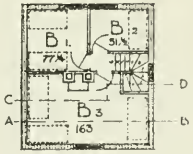
DETAIL SECTION C D

SECTION AB

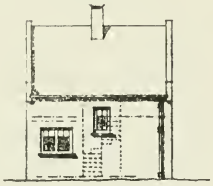
WEST ELEVATION

EAST ELEVATION

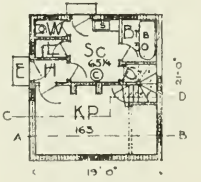
NORTH ELEVATION



FIRST FLOOR PLAN

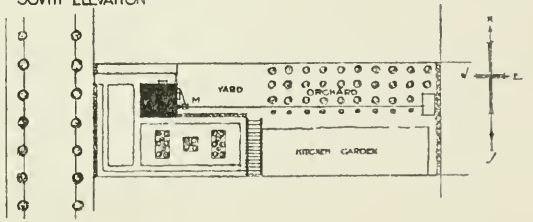


SOUTH ELEVATION



GROUND PLAN

ROOM	DIMENSIONS		AREA	CONTENTS
HALL	4'-6" x 3'-3" x 8'-0"	=	14¾	118
K & PARLOUR	17'-6" x 10'-0"	=	163	1304
SCULLERY	9'-0" x 7'-3"	=	65¼	522
BEDROOM 1	9'-0" x 8'-7"	=	77¼	618
" 2	8'-7" x 6'-0"	=	51½	412
" 3	17'-6" x 10'-0"	=	163	1232
BATHROOM	6'-0" x 5'-0"	=	30	240
LARDER	4'-6" x 2'-6"	=	11¼	90
W.C.	4'-6" x 2'-6"	=	11¼	90
			SQ FEET	CU FEET



BLOCK PLAN

SCALE 8 FEET TO 1 INCH

FIG. 104.—DESIGN NO. 58. BY C. T. MITCHELL.

With Design No. 229. (By G. E. Clare, M.S.A., Atlas Chambers, 2, Berridge Street, Leicester.)

Description and Remarks.—The salient points of the two designs submitted are as follows :—

Adaptability of Plans.—To either detached or semi-detached cottages.

Compactness of Plan.—To ensure economy in initial cost and saving in domestic labour.

Convenience and Comfort.—All rooms, staircase, etc., grouped round main entrance lobby and landing. From the entrance lobby in Type A access is obtained to the living-room, coals, scullery, W.C. and staircase, no apartment being a passage room.

The Staircase is conveniently placed for conveying furniture, etc., to the bedrooms or approaching them without passing through a room.

The Living Rooms are of ample dimensions ; fireplaces being well removed from outside doors, the rooms would be comfortable and free from draughts.

Sculleries are spacious, and fittings conveniently placed ; copper, sink and bath space are shown. A glass door or borrowed light is provided to give supervision of living-room fireplace when working in scullery. In Type A, scullery is entered from lobby, to avoid steam entering living-room on washing days.

W.C.'s and Fuel Houses are of ample size and in Type A are approached from entrance lobby to avoid exposure in winter. The W.C. is also convenient for access from bedrooms.

Larders are of good size, well lighted and ventilated.

Bedrooms are spacious, well lighted and conveniently planned for furniture and beds. All bedrooms have sunny aspects.

The designs are two examples of cottages in patent standardised concrete slab construction, with damp-proof outside walls 9 in. thick with 3-in. air cavity.

The objects of the special construction are as follows :—

Simplicity and Economy in construction. The walls and window-frames can be made and erected by intelligent unskilled labour, thus effecting a great saving in initial cost.

The Construction can be carried out without the use of scaffolding, trestles being used up to first floor line, and above that the joists would be utilised.

Concrete would be used for walls, partitions, roof tiles, window-frames, sinks, mantels, etc., and made on the site from very inexpensive raw material for the aggregate, by means of a simple and cheap moulding machine, thus effecting a great saving in carriage.

Structures being Standardised, and formed with much larger units than ordinary building construction, they can be erected much quicker and cheaper, *e.g.*, walls have only eight slabs and four ties to the super yard, as against 100 bricks, or less than one-tenth the number to handle and fix.

A two-light window has only five pieces of concrete, which are simply placed in position as erected.

Concrete Roof Tiles number only 100 to the square, as against 600 plain tiles.

Footings and Foundations are reduced to a minimum, owing to the weights of the walling being only about one-third that of an ordinary solid brick wall.

Buildings are Perfectly Dry and ready for occupation when complete, as slabs are dry when built up.

The Cost of Upkeep is reduced to a minimum, as there are only the eaves, gutter and down pipe to paint.

Lintels, Wood Blocks and Grounds eliminated, and cost saved, as slabs being made of breeze concrete can be used for nailing to.

With Design No. 9. (By John Dall, 179, Gilmore Place, Edinburgh.)

Description of the Building.—The cottage has been designed mainly in concrete. The entrance to the building leads to a small entrance hall, which gives indirect access to a large living room, which is well lighted, is of good height and roomy to a degree. Off the living room a larder has been shown with ample shelf accommodation, while in addition to this the space under the stair could be utilised for storage. The scullery or working kitchen is also

of good size, and shows the spaces reserved for bath, copper and sink; while adjoining the sink a large cupboard is shown, also a place for coals. The back door gives indirect access to the scullery by a lobby, off which opens the W.C. All these apartments are well lighted. The plans show the disposition of the various fittings, and the bath, when fitted up, would be a fixture, having a hinged table top for use when the bath is not required by the inmates. An easy stair leads to the bedroom floor, in which are situated three good-sized bedrooms. The front bedroom is of good size, and a hanging cupboard is arranged off this room. The two smaller rooms are of ample size and well lighted. The disposition of the beds is shown by dotted lines. It will be noticed that fireplaces are shown in every room, and these are all in the centre of the building, thereby ensuring a warm and comfortable house throughout.

The flooring of the living-room and bedrooms would be of deal boards, the bedroom flooring being nailed to the breeze concrete, of which the floors, as well as the roof, would be constructed. The walls inside and the ceilings would be plastered in two-coat work. The only joinery finishing would be the doors and windows, so that the cottage is practically fireproof. Externally the building has been designed in the simplest possible manner. The aim of the author has been a square house, or as nearly so as possible, all the accommodation being arranged within the four walls, thus obviating the necessity of throwing out the usual projections for offices, etc., which are too common and ugly a feature of many houses of this class. The cottage has no useless or unsightly features, a good *line* of walls and roof being aimed at, and a well-defined central chimney stack and small front gable being sufficient to give the whole the necessary architectural balance.

The roofs would be covered with cement tiles, with cement ridges. The windows would be plain frames and sashes of white deal, as shown on the ½-in. detail. The doors would be white deal, framed and lined, with braces and plain facings, no mouldings of any sort being used anywhere in the building.

The author claims that every available inch of space in the plans has been successfully taken advantage of, and no space wasted in useless passages, etc., and the plans clearly show that a suitable house for a labouring man and his family can be designed, conveniently planned, and at the same time architecturally correct.

With Design No. 58. (By C. T. Mitchell, P.O. Box 3952, Johannesburg, South Africa.)

Description.—The building is detached, two storeys, each 8 ft. from floor to ceiling, the upper storey being partly in the roof. The space under the low portion of the ceilings is occupied in all cases by the beds, thus giving all the clear floor space abundant head-room,

An infant's bed is intended to be placed in the large bedroom with the parents.

A fireplace is provided in one bedroom only, in case of illness.

The aspect of the house is arranged to give a maximum of sunshine in the parlour, kitchen, privacy to the front entrance, coolness to the larder, and a simple arrangement of drainage connections. The two back bedrooms get the morning sun and the front room the afternoon sun.

It has been assumed that the premises will only be accessible from the front road.

It is understood that the drawings submitted herewith form only a portion of what would be necessary for the erection of the building by a local builder. Complete details of all the reinforcement, etc., would be given together with a full specification.

With Design No. 227. (By D. A. Beveridge, Prudential Buildings, 36, Dale Street, Liverpool.)

The merits claimed for this design are as follows :—

(1) All three bedrooms are on first floor, thereby giving a better arrangement and saving considerably on the cubic contents of design, as the small bedroom is placed over W.C., coals and larder, all of which are about 6 ft. 3 in. floor to ceiling.

(2) Large coal and larder accommodation.

(3) One chimney stack only required, and all fireplaces on inside walls.
(4) Staircase lit by window.
(5) Entrance door has no direct communication with living-room.
(6) All rooms of good size.
(7) No winders in staircase.
(8) Cement footpath at back.
(9) Good appearance from roadway. Cement slates are used to a certain extent to give a more rustic effect, and walls limewhited. Woodwork to be painted apple-green.
(10) External walls being hollow, this will ensure a dry house.
(11) Pipe will be provided to carry hot water from copper to bath.

With Design No. 76. (By Chas. B. Pearson, 109, High Road, Chiswick, W.

The author has endeavoured to carry out the conditions of the Competition. The areas of the rooms have been closely adhered to, and the accommodation provided is, in his opinion, consistent with cost.

Concrete to be used wherever possible and the amount of woodwork reduced to a minimum. This being necessary in the case of doors, cupboards, etc.

It is proposed that the floors and roof be of concrete. The floor surfaces to be finished with a patent composition, such as " Dolomeut," or other approved method.

The roofs to be covered with approved concrete tiles. If not contrary to the spirit of the Competition, it is suggested that a good coloured red tile would form a very fine contrast to the other portions of the buildings.

The walls and chimney stacks to be in concrete built *in situ*, the interior partitions to be in slab concrete. The external faces of the walls where shown on drawings to be finished in plaster or rough cast trowelled smooth.

All woodwork has been eliminated from windows, the method proposed being shown on the details.

With Design No. 97. (By E. W. Stubbs, Grayshott, Marlborough Road, South Croydon.)

Special attention has been given to rendering these cottages as simple as possible, both in design and construction. The plan provides access to fuel store and W.C. under cover of a lobby, while access from bedrooms to W.C. is arranged without the necessity of passing through the living-room.

The porches shown are to have the sides covered with trellis, on which could be grown, say, crimson rambler or clematis, thus providing shelter to the entrance, and affording a pleasing and appropriate form of ornament.

The walls are substantially constructed of hollow concrete blocks 8 in. thick, covered externally with cement rough cast as an additional precaution against the weather.

The internal finish to consist of the smooth face of blocks finished with two coats of washable distemper.

Standardisation of doors and windows has been adopted throughout, and the chimneys and fireplaces are to be formed of special 4-in. blocks.

The simplicity of the construction will be evident on reference to the plans, which show foundations, floors and roof in complete detail.

With Design No. 158. (By J. K. Frazer, Silverwells, Crescent, Bathwell, N.B.)

The accompanying design in the *Concrete and Constructional Engineering* competition for labourers' cottages has been worked out on the semi-detached principle. The outer walls are built throughout with hollow concrete blocks in lengths of about 2 ft. 9 in., the two faces moulded together with galvanised iron diaphragms or ties. The general body of the walling would be in " fine dabbed " 6-in. courses, random jointed, and the corners, door and window rybats and chimney stalks would be in 12-in. plain or " angle batted " courses. Partitions would be 3 in. thick and party walls 4½ in. thick, of breeze concrete in 12-in. courses. The

foundations concrete, and the whole area under wood and concrete floors to have a $\frac{3}{4}$-in. layer of rough asphalte. Door and window lintels would be of reinforced concrete. There would be absolutely no connection between the outer and inner faces of walls except by the iron diaphragms or ties, and these would be grooved vertically in their centre, in order to check or arrest any moisture tending to pass along from the outer to the inner face. Lathing and strapping is thus dispensed with, and at the same time freedom from wall damp is assured at every part of the structure. Walls in apartments would have a $\frac{3}{16}$-in. coat of plaster finished white; those in the scullery, bathroom, etc., moulded smooth and flush pointed with cement in the joints. The outside of the building has been treated very simply, exposed woodwork being at a minimum, so that the annual upkeep would thereby be reduced. In order to obtain a little contrast in colour and an artistic appearance, the following courses would be moulded in white cement: apex course and skews at bedroom windows, skews and eaves courses on gables, 6-in. course at ground floor level, the raised back fillet on alternate corners of rybats, corners, etc., and courses at level of window lintels. All other work would be moulded to the natural grey colour of the cement, the 12-in. course at ground level being in "broached" or "rock-faced" work. Roof covering would be $11\frac{3}{4}$ in. by $11\frac{3}{4}$ in. diagonal "Eternit" slates, blue in colour. If the copper be raised slightly and a draw-off tap taken through the wall and over the edge of bath, hot water would thus be readily obtained.

With Design No. 195. (By W. G. Davies, 94, Jesmond Avenue, Manningham, Bradford.)

The design submitted is for semi-detached houses suitable for homes for labouring men in the West Riding of Yorkshire. The houses have been carefully planned to afford the greatest possible convenience and accommodation for the money spent. Due consideration has been given to the thoroughly hygienic conditions of family life in the arrangement of rooms and facilities for an improved state of living.

The entrance door is placed at the side, thus leaving the entire and pleasant west aspect of the house for the living-rooms. Entrance is made into a small hall from which also the staircase to first floor leads. Both the living-room and parlour are directly entered from the hall.

The parlour is detached from that portion of the house allotted to working purposes.

The living-room has been so planned, with doors in one corner, that it does not become a passage to another part of the house. It is of convenient size, and is provided with kitchen range, and a china cupboard in recess.

A scullery, fitted with sink, copper and bath—the latter having hinged cover to serve as table—is easily accessible from living room and garden.

The pantry is large and light, and can be directly entered from living-room and scullery.

A W.C. and a store-house for coal are provided; both are entered from yard, but easily accessible from scullery.

Three bedrooms, each directly entered from landings, are provided on first floor, and are so planned that each may contain two single beds.

The adult bedroom is so placed as to intercept any communication between boys' and girls' rooms.

In girls' room a convenient cupboard is built over stairhead.

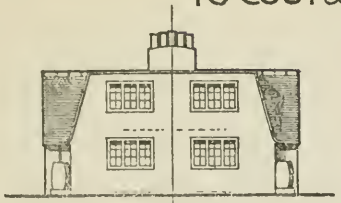
With Design No. 20. (By Chas. King, 15, Ormonde Road, East Sheen, S.W.)

The accompanying drawings show semi-detached cottages with kitchen, parlour, scullery and offices on ground floor, and on first floor one large bedroom for two adults and two children, and two smaller bedrooms. A good cupboard or larder, with window, is provided, opening out of scullery, also a store cupboard opening out of kitchen parlour, and a fuel store.

The external and party walls to be of concrete, the roof of corrugated iron protected by concrete surface covering. The partitions to be in concrete slabs of the Hercules type.

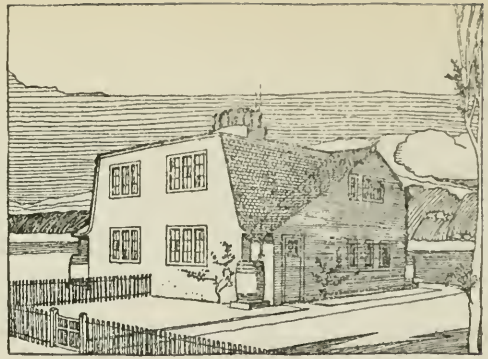
The elevations are treated simply. The concrete to be exposed as facing material, and only relieved by a few cement quoins and lozenges. The projecting window of staircase is extended to form a shelter over entrance door.

A PAIR OF CONCRETE COTTAGES
TO COST £125 EACH

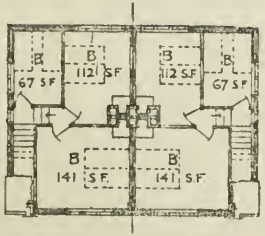


FRONT ELEVATION

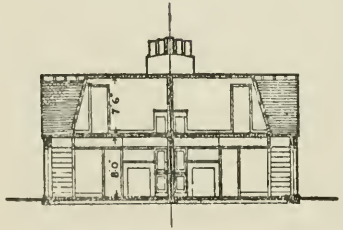
BACK ELEVATION



VIEW FROM ROAD



FIRST FLOOR

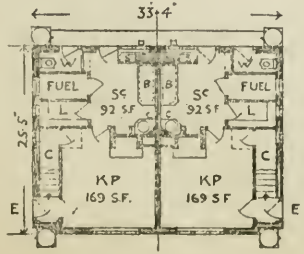


SECTION

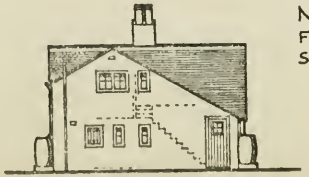
	SIZES OF ROOMS	FLOOR AREAS	CUBIC CONTS.	HEIGHT
KP	13·6×12·7	169	1352	8·0
SC	10·2×8·10	92	736	8·0
F	6·8×3·4	22	137	6·3
L	6·8×3·4	22	137	6·3
B	12·7×11·3	141	1057	7·6
B	12·9×8·10	112	840	7·6
B	10·2×6·8	67	502	7·6

TOTAL CUBIC CONTENTS OF PAIR MEASD OUTSIDE · 14334
EST. TOTAL COST P PAIR · £250
PRICE PER CU. FT. 4½D

TABLE OF SIZES

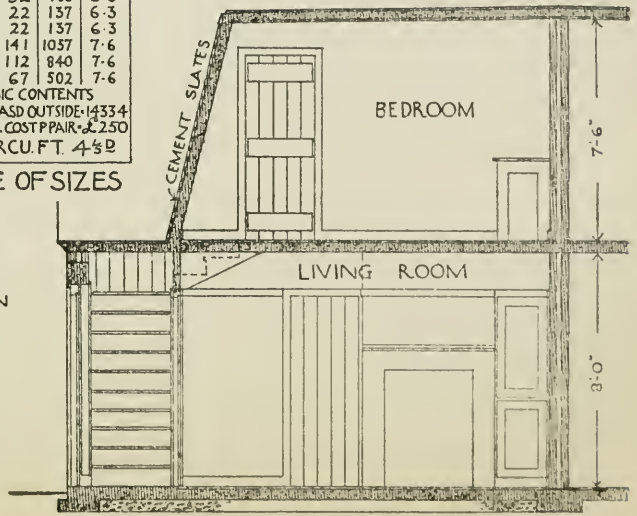


GROUND FLOOR

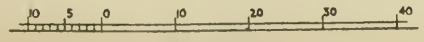


END ELEVATION

NOTE:
FOR BLOCK PLAN
SEE REPORT.



HALF-INCH DETAIL



SCALE OF FEET

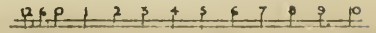
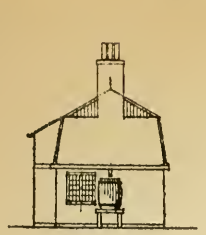
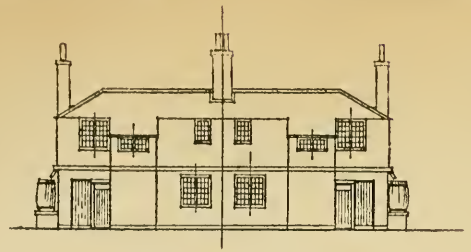


FIG. 105.—DESIGN NO. 227. BY D. A. BEVERIDGE.

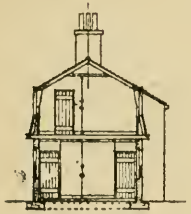
CONCRETE COTTAGE COMPETITION



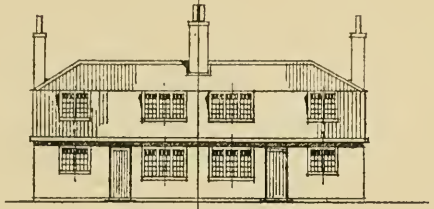
END



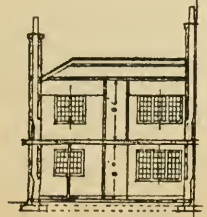
BACK ELEVATION



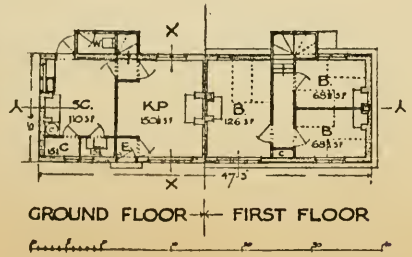
SECTION X-X



FRONT ELEVATION



SECTION Y-Y



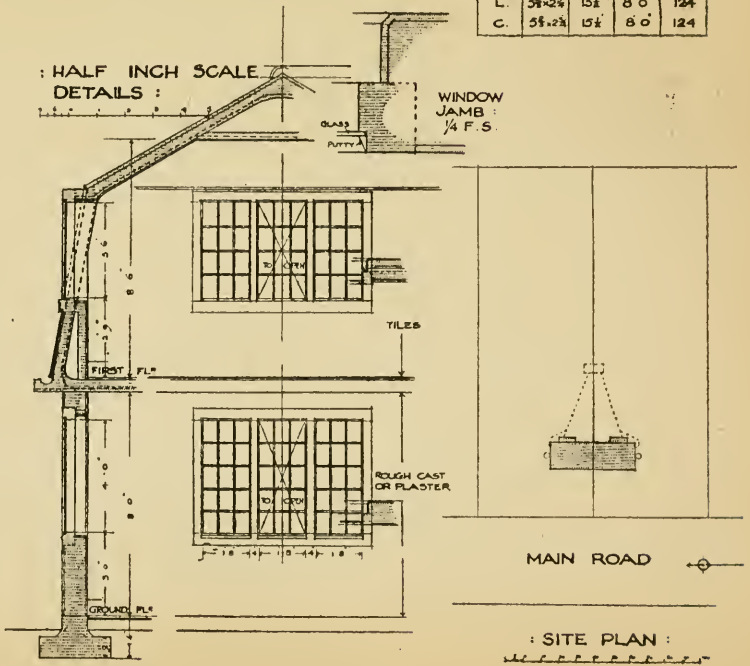
GROUND FLOOR — FIRST FLOOR

CUBIC CONTENTS = 14,600 C. FEET.

: TABLE :

ROOM	SIZE	SUP.	HEIGHT	CUBE
E.	3×3 (oct.)	9	8'0"	72
K.P.	14×10¾	150½	"	1204
SC.	11×10	110	"	880
B.	14×9	126	8'0"(M)	1008
B.	10×6'10	68½	"	548
B.	10×6'10	68½	"	548
L.	5¾×2¾	15½	8'0"	124
C.	5¾×2¾	15½	8'0"	124

: HALF INCH SCALE DETAILS :



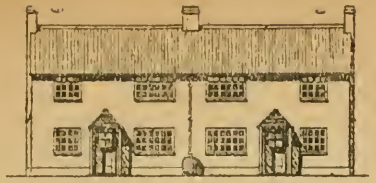
SECTION THRO' EXTERNAL WALL

PART ELEVATION

: SITE PLAN :

FIG. 106.—DESIGN NO. 76. BY CHAS. B. PEARSON.

PROPOSED PAIR OF CONCRETE COTTAGES

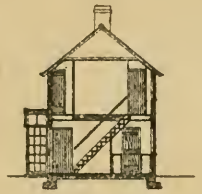


WEST ELEVATION.

SOUTH ELEVATION.

NAME OF ROOM.	SIZE.	AREA.	HEIGHT.	CUBIC CONTENTS.
LIVING ROOM (KP)	14'8" × 10'3"	150 sq. ft.	7'9"	1160 cu. ft.
SCULLERY (Sc)	9'0" × 8'6"	76 " "	7'9"	590 " "
BED ROOM (B¹)	14'8" × 9'0"	132 " "	8'0"	1020 " "
BED ROOM (B²)	10'8" × 8'0"	84 " "	8'0"	650 " "
BED ROOM (B³)	7'6" × 6'6"	48 " "	8'0"	380 " "

EAST ELEVATION.



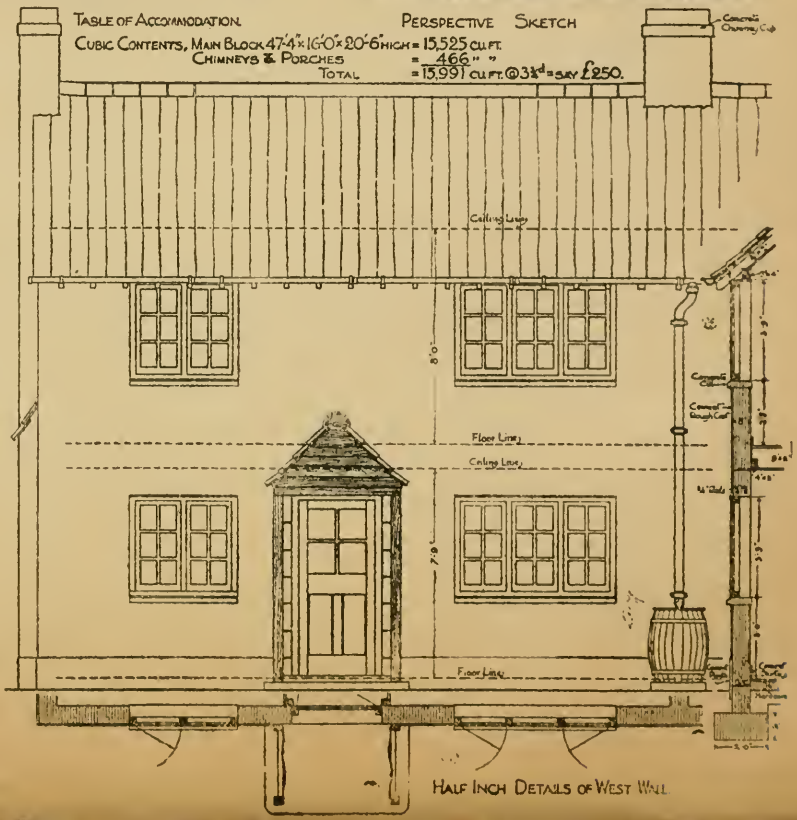
CROSS SECTION

⅛ INCH SCALE

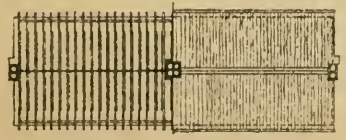
TABLE OF ACCOMMODATION.

CUBIC CONTENTS, MAIN BLOCK 47'4" × 16'0" × 20'6" HIGH = 15,525 CU. FT.
CHIMNEYS & PORCHES = 466 " "
TOTAL = 15,991 CU. FT. @ 3½d = SAY £250.

PERSPECTIVE SKETCH

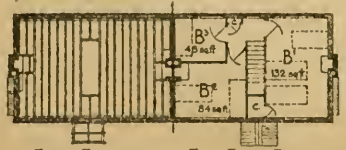


HALF INCH DETAILS OF WEST WALL



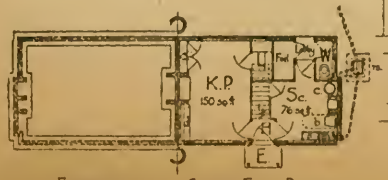
ROOF FRAMING

ROOF PLAN.



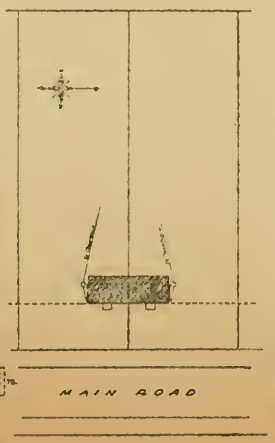
FLOOR FRAMING.

FIRST FLOOR PLAN.



FOUNDATIONS.

GROUND FLOOR PLAN.



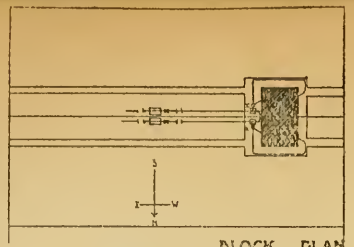
BLOCK PLAN.
1/16 INCH SCALE.

FIG. 103. DESIGN No. 25. BY F. W. STUBBS.

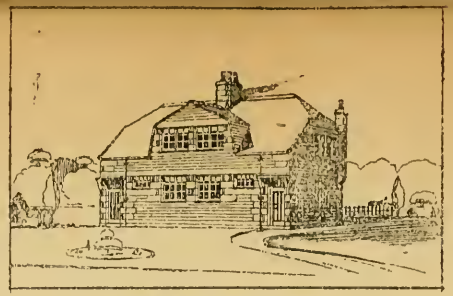
CONCRETE AND CONSTRUCTIONAL ENGINEERING

£125 CONCRETE COTTAGE COMPETITION

ESTIMATED COST
£249-16-6 PER PAIR

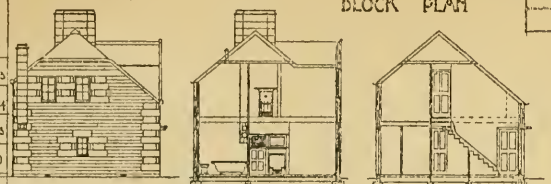


BLOCK PLAN



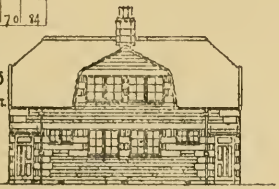
PERSPECTIVE VIEW

ROOMS	DIMENSIONS	FLOOR AREAS	HEIGHT	CUB. CON
P	15 0 / 15 0	163	7 6	1223
S_c	3 3 / 3 7	51	7 6	374
P_1	15 0 / 15 0	152	8 0	1123
D_2	7 3 / 8 3	61	8 7	440
D_3	7 3 / 7 7	55	8 0	400
D_1	7 0 / 7 0	24	7 6	183
L	5 3 / 3 0	17	6 3	86
F	4 0 / 3 0	12	7 0	84

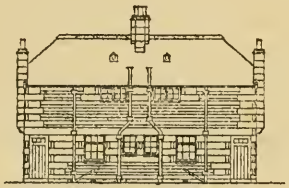


END ELEVATION SECTION A.B. SECTION C.D.

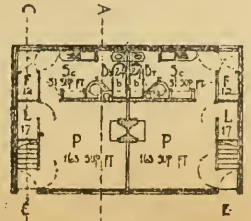
CUBIC CONTENTS 15180 CUB. FT.



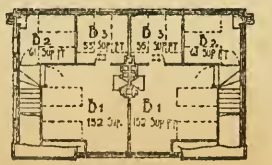
FRONT ELEVATION



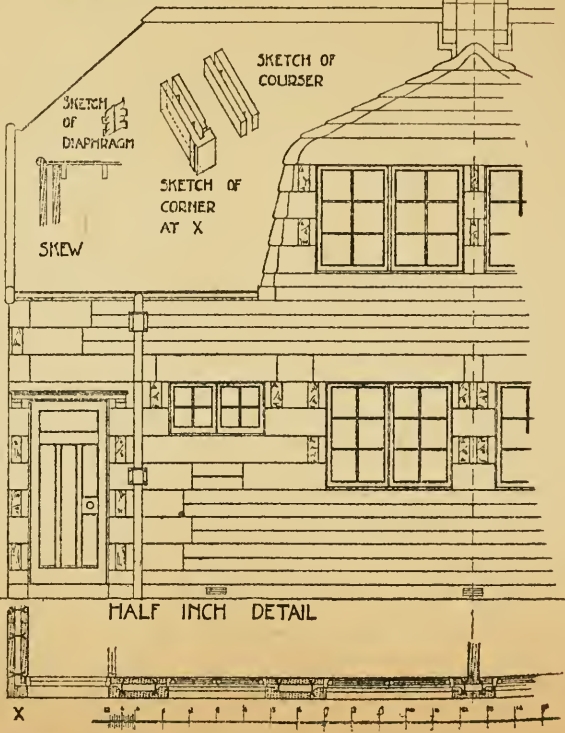
BACK ELEVATION



GROUND PLAN



FIRST FLOOR PLAN



HALF INCH DETAIL

FIG. 108.—DESIGN NO. 158. BY J. K. FRAZER.

With Design No. 21. (By Percy May, 235, Devonshire Road, Forest Hill, S.E.)

The cottage stands upon a black (asphalte) base; the ground floor walls are lime-whited on the concrete left rough from the centering, while the first floor wall timber framed with concrete in-filling, and set back 6 in. from the general face, is covered with silver grey "Fibrocement" sheeting, a similar material being used for the roof. All woodwork, internally and externally, is solignumed. The casement window is used.

As regards plan, the central staircase is the keynote, having on one side the living room, lighted east and west, and on the other a bedroom, while behind is the scullery with bath and copper and separate W.C. The rain-water tanks shown are not included in the estimate.

The floors are covered with a strong linoleum, laid direct on the concrete with mastic. Several cupboards are provided.

The first floor contains two bedrooms with hanging cupboards, and also a large cupboard.

Flues are carried up over staircase to central stack.

Foundations are shown as 9-in. concrete, 12 in. below ground level. This might be diminished according to the nature of the subsoil.

With Design No. 44. (By G. Ll. Morris, Licentiate R.I.B.A., 40, Finsbury Square, E.C.)

Character of Design.—The author has attempted to realise a pleasant, artistic and inexpensive design along lines suggested by the nature of the chief material and the method of construction. Concrete has been frankly accepted as the chief factor in its treatment, and this has called for a design distinct from those based on the old traditions of cottage building. Care has been taken to obtain a good arrangement of voids and solids. It is also proposed that the elevations should be generally whitewashed, and the portion under the ground floor windows tarred to the height shown, and also the curved portions between windows. It should be noticed that the line showing the base on the elevations is not constructional, but merely indicates the top of the tar base all round the cottage. Parts of the cornice also would be tarred. The window and door frames externally to be painted black and the sliding casements and dividing bars white. The general effect aimed at being white and black, the white predominating.

Method of Execution for the External Walls.—The external walls are to be cast in slabs, three for the front, two for each side, and six at the back. The six at the back divided as follows: two for the projecting wings, two for the recessed portion (these being horizontal divisions), and two for the short returns. The moulds are to be a raised level staging formed of the reversed sides of the floor boards. The window and door frames laid in position and the concrete poured into the mould and screeded off to the right thickness, 4 in. in the panels between head and ground floor windows and first floor cills, and 5 in. in the piers between windows and up to ground floor window cills. The reinforcements consist of $\frac{3}{4}$-in. steel rods placed 8 in. apart both vertical and horizontal, leaving the rods projecting at the ends; these are bonded together at the corners and vertical joints, and made good with concrete afterwards. Cornices for the plates to receive the joists to be cast on the walls. The breasts of fireplaces are to be of brick and linked to the reinforced concrete. For this purpose steel rods are to be left projecting from the concrete. The breasts of fireplaces in No. 3 bedroom are to be built on a slab of concrete laid across the angle from the external wall to the internal cross walls. The internal walls are to be $2\frac{1}{2}$ in. thick, cast on the floor. The reinforcements of the flat slab roof are to be $\frac{3}{16}$-in. barbed wire of cross mesh 6-in. centres, strengthened with concrete beams on the outside of the roof. The slab to be trowelled after it has properly set. The internal faces of external walls, the faces of partitions and ceilings upstairs to be merely skimmed with plaster at the finish. The external face of concrete walls to be finished

with a thin coating of hand-floated cement and twice limewhite. The limewhite to be mixed with alum so that it will not wash off. The mortar for brickwork to be 1 part stone-lime and 3 parts clean sharp sand. That used for plastering ceilings of ground floor to be mixed with cow hair. Build up the footings of chimneys with two courses of brickwork. Form arches over fireplace openings on wrought-iron bars. Form flues 9 in. by 9 in., parge and core same.

With Design No. 124. (By Austin Vernon, 5, Duncan Terrace, Islington, N.)

The erection of a cottage in solid materials like concrete for £125 is a difficult problem, and only by pinching every detail very tight can one expect to get anywhere near such a figure.

In the design the following points have been in the author's mind as ways of keeping the price as low as possible :—

(1) A low one-storey building reduces the scaffolding and plant required to a minimum, also labour in connection therewith. It also saves a great deal of labour-raising material to a height.

(2) Manufacture of concrete blocks on the site with materials obtainable locally as far as possible as aggregate. By this means it is possible to handle the concrete in a more convenient form. Whatever locality one may select, some good aggregate is usually to hand.

Concrete blocks can be manufactured by unskilled labour on a rough boarded platform divided by boards of the size necessary for the required thickness, say, 2 ft. by 1 ft. by 5 in. Smaller blocks would also be required about the size of bricks for constructing flues, etc. The fronts of the fireplaces could also be cast in a similar manner about 3 in. thick and grouted solid in position. Shelves, steps, sinks and lintels could all be cast to sizes given.

The building could be roofed with pantiles, or with a cement tile, which could be tarred, and would give an artistic effect in contrast to the rough cast.

With regard to plan, space is arranged beside copper for a folding bath. A Larbert range is proposed in the kitchen-parlour. Cement floors to kitchen-parlour, entrance and scullery. Bedroom floors could be boarded, but these might well be finished cement. The space not lettered on plan is for wood and coals.

With Design No. 238. (By R. I. McBeath, Birnam House, Sale.)

The design is manifestly so simple and straightforward that little or no description of the planning appears necessary. The following merits may, however, be pointed out :—

(1) The kitchen-parlour is free from any passage-way between one room and another in the vicinity of the fire or window.

(2) The scullery provides ample and good spaces for sink and bath, with short direct wastes from each discharging over one gully.

(3) The staircase is of good width and well lighted.

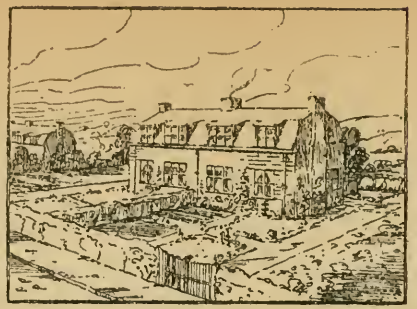
(4) The bedrooms provide good positions for the requisite twin beds, and with easy access thereto.

(5) The W.C. and coal store are each approachable under cover, yet to all intent outside the dwelling.

It is proposed to erect the cottages with 10-in. external walls, consisting of two 4½-in. solid concrete blocks, with an inch cavity between and bonded with galvanised iron ties. The ground floor rooms would have 4½-in. solid block walls, and the first floor rooms $2\frac{13}{16}$-in. cement slab partitions. The ground floor is proposed to be of concrete 5 in. thick, and the first floor of Johnson's lattice reinforced concrete 4½ in. thick. Each floor would be screeded up to the foregoing thicknesses and trowelled to a smooth face to receive linoleum if desired and all rooms would have fibro-cement skirtings. The roof would be covered with fibro-cement slating laid diagonally to a 2¾-in. gauge with Willesden paper underlinings, and provided with fibro-cement ridging.

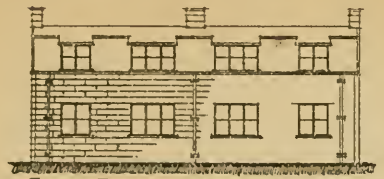
CONCRETE COTTAGE COMPETITION

		Area	Height	Cub Cont
H.	10·0 · 2·9	27·6	8·6	233·9
P.	10·0 · 8·9	87·6	8·6	743·9
KP	14·6 · 11·0	152·6	8·6	1296·3
Sc.	8·6 · 8·0	68·0	8·6	578·0
B.	14·6 · 11·0	140·0	8 Cant	1120·0
B.	12·0 · 10·0	120·0	8·0 ·	960·0
B.	11·0 · 8·6	93·6	8·0 ·	748·0
	4·0 · 2·3			
L.	4·6 · 2·3	27·4	8·6	232·4



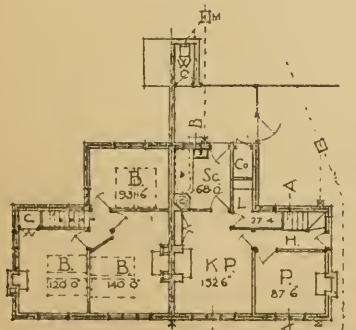
Cubic Contents of Building measured from bottom of footings to apex of roof

	Cubic Ft
45·0 × 16·0 × 21·0 high =	15120
24·3 × 8·3 × 21·0 " =	4200
Total cubic feet	19320



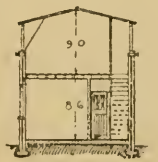
FRONT ELEVATION

BACK ELEVATION

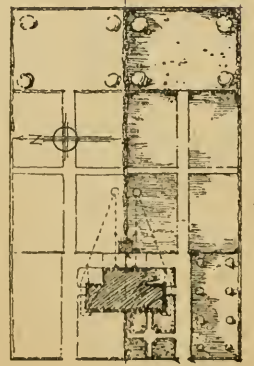


HALF PLAN OF FIRST FLOOR

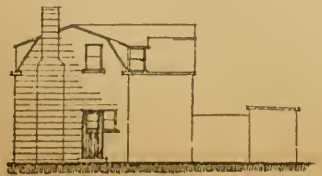
HALF PLAN OF GROUND FLOOR



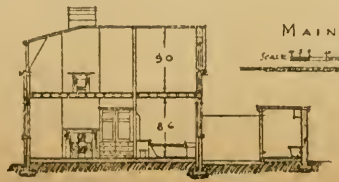
SECTION A.A.



MAIN ROAD

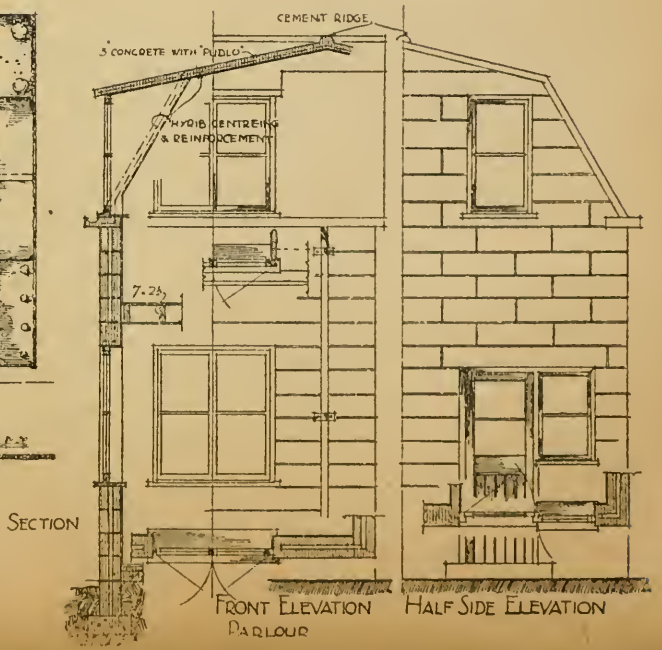


SIDE ELEVATION



SECTION B.B.

SCALE



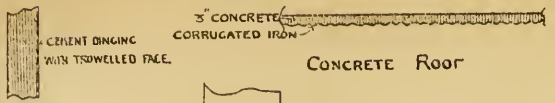
SECTION

FRONT ELEVATION PARLOUR

HALF SIDE ELEVATION

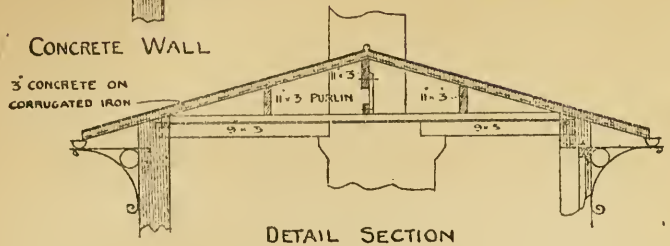
FIG. 109.—DESIGN NO. 195. BY W. G. DAVIES.

CONCRETE COTTAGES



CONCRETE ROOF

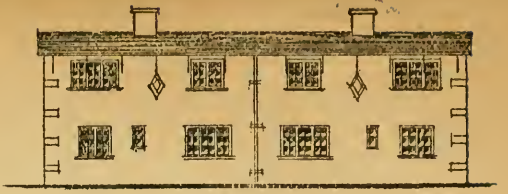
CONCRETE WALL



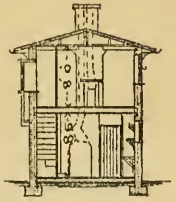
DETAIL SECTION

½ INCH SCALE

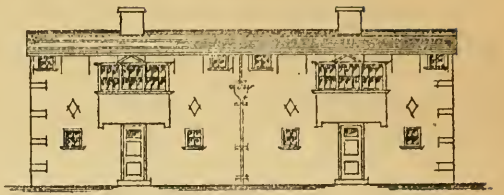
END ELEVATION



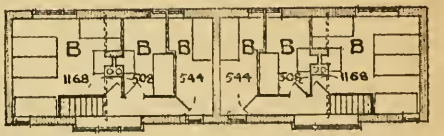
BACK ELEVATION



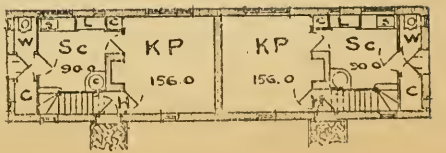
SECTION.



FRONT ELEVATION

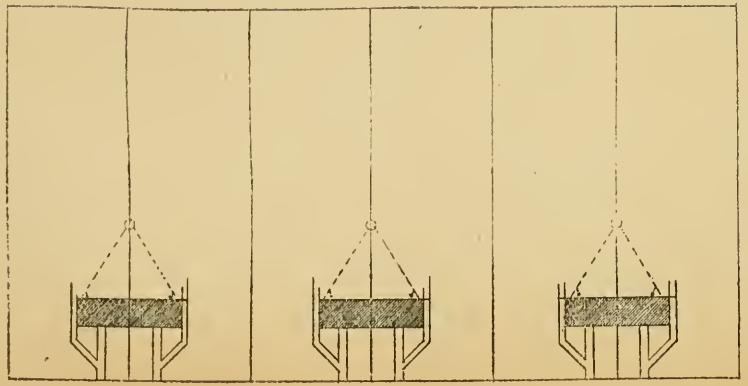


FIRST FLOOR PLAN



GROUND PLAN

⅛" SCALE



BLOCK PLAN

1/32" SCALE.

CUBICAL CONTENTS
8920 FEET.

TABLE

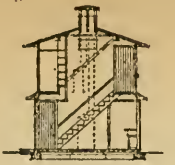
ROOM	LENGTH	BREADTH	AREA	HEIGHT	CUBE
KP	13.0	12.0	156.0	8.6	1326
Sc	10.0	9.0	90.0	8.6	765
B	12.0	11.9	140.0	8.0	1188
B	10.0	6.4	63.6	8.0	504
B	13.0	5.3	68.0	8.0	544

FIG. 110.—DESIGN NO. 20. BY CHAS. KING.

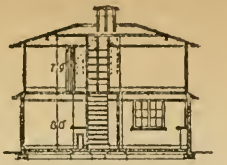
A CONCRETE COTTAGE TO COST £125

SCALE 8 FEET TO 1 INCH

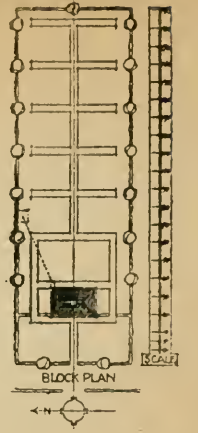
SKETCH FROM SW



CROSS SECTION

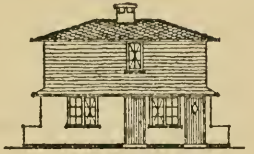


LONG SECTION



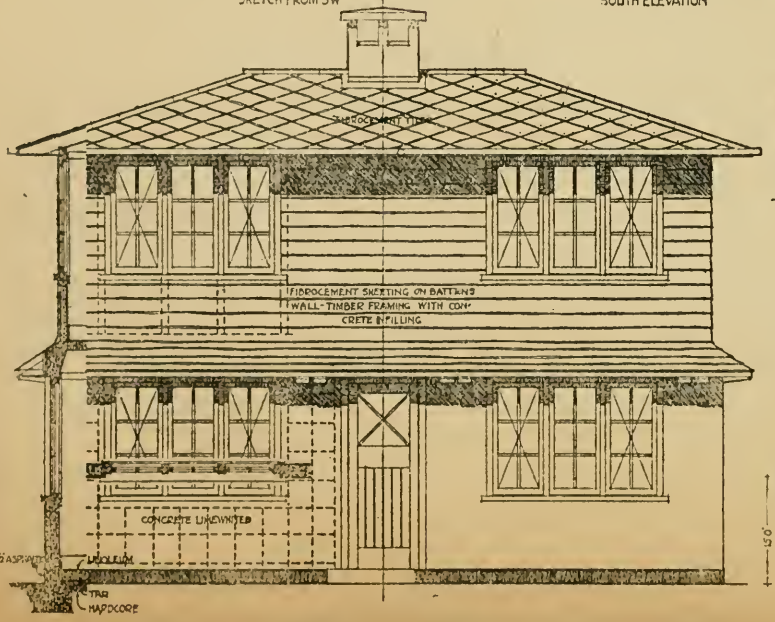
BLOCK PLAN

SOUTH ELEVATION



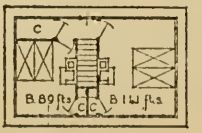
EAST ELEVATION

NORTH ELEVATION

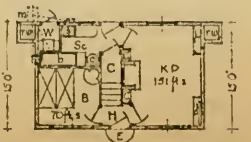


HALFINCH DETAIL OF FRONT

FRONT ELEVATION



FIRST FLOOR PLAN

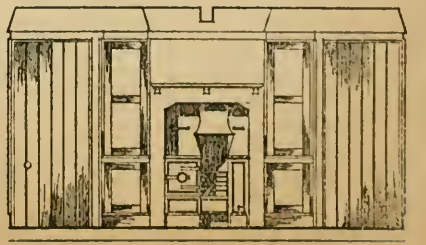


GROUND FLOOR PLAN

CUBIC CONTENTS

24 / 15 / 9·5 + 23 / 14 / 8·5 = 6156 CUBIC FEET

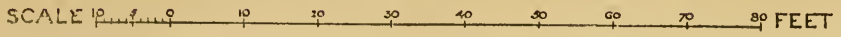
ROOM	LENGTH	WIDTH	SUPER AREA	HEIGHT	CUBIC CONTS.
H	4'0"	5'0"	12·00	7'9"	93·00
K.P.	14'0"	11'0"	151·00	7'9"	1180·25
Sc.	8'6"	5'9"	57·875	7'9"	448·531
B.1	8'9"	8'0"	70·00	7'9"	542·500
B.2	10'6"	8'6"	89·25	7'9"	691·687
B.3.	15'6"	10'6"	141·75	7'9"	1098·562



HALFINCH DETAIL OF KP

FIG. 111.—DESIGN NO. 21. BY PERCY MAY.

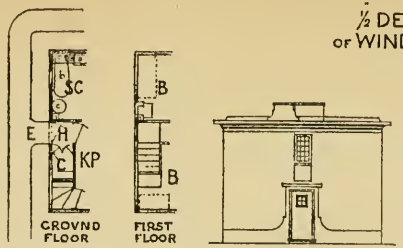
£125-CONCRETE-COTTAGE COMPETITION



	SIZES	AREAS	HEIGHT	CVBIC CONTᵗ
LIVING RM	13·1 x 11·9	153·9	7·6	1163·1½
SCVLLERY	8·6 x 8·0	68·0	"	510·0
BED·RM I	14·6 x 9·0	130·6	"	978·9
BED·RM II	8·6 x 8·0	68·0	"	510·0
BED·RM III	8·6 x 8·0	68·0	"	510·0
LARDER	5·6 x 2·6	8·9	"	65·7½
CLOSET	5·6 x 2·10	15·7	5·6	85·8½
W·C	3·6 x 2·6	8·9	7·6	65·7½
COAL	3·6 x 2·9	9·7½	"	72·2¼

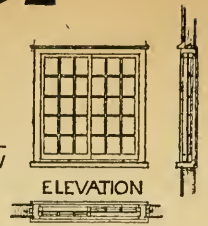
THE CVBE 1105½·8

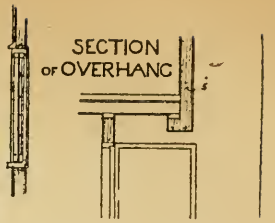
TABLE

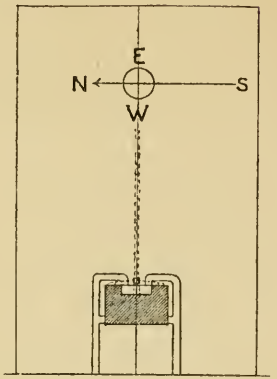


ALTERNATIVE-SIDES

½ DETAIL OF WINDOW

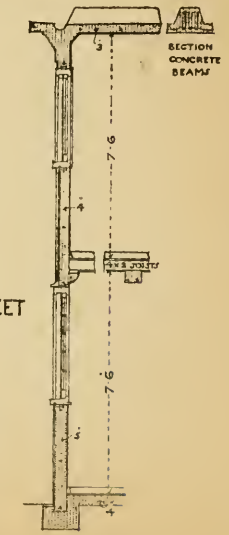




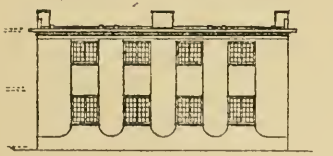


SITE PLAN

SECTION THRO' FRONT WALL

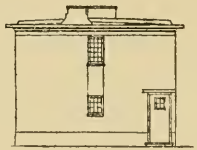


½ SCALE



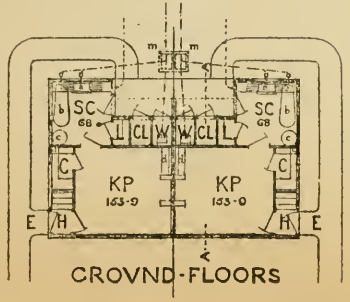
FRONT

BACK

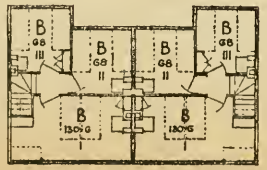


SIDES

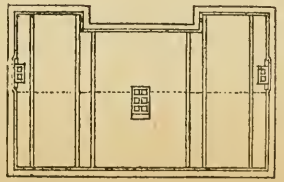
SCALE 0 10 50 100 120 FEET



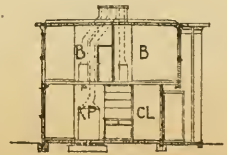
GROVND-FLOORS



FIRST-FLOORS



ROOF



SECTION-A-A

Fig. 112.—Design No. 44. By G. Ll. Morris, Licentiate R.I.B.A.

DESIGN FOR A PAIR OF SEMI-DETACHED CONCRETE COTTAGES.

SCALE 8 FEET TO 1 INCH

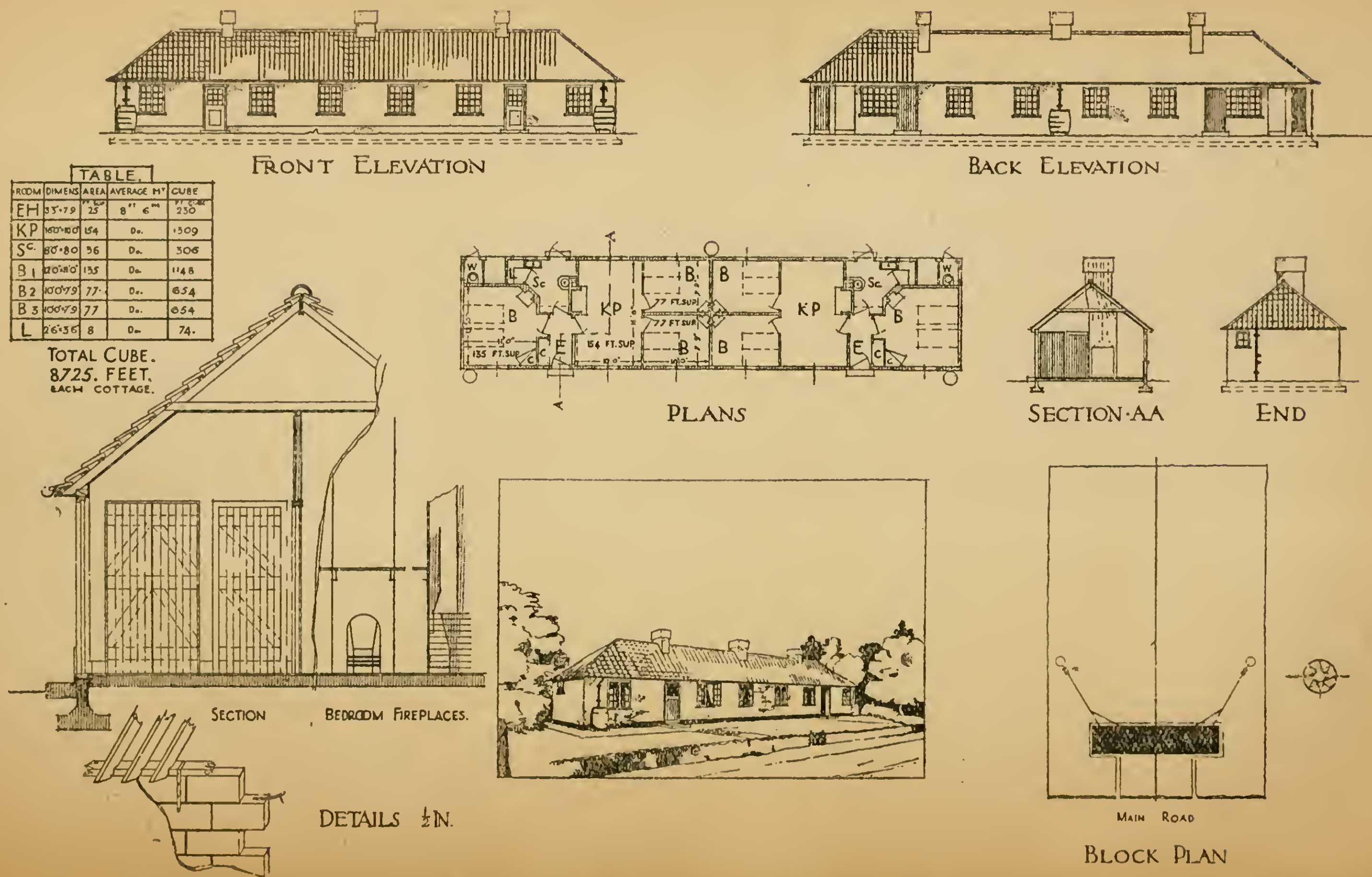


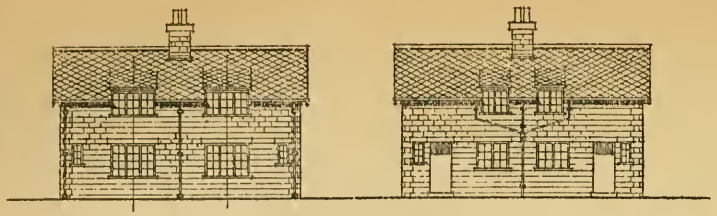
TABLE.

ROOM	DIMENS	AREA	AVERAGE H^T	CUBE
EH	3'5·7'9	25	8' 6"	230
KP	16'0·10'0	154	Do.	1309
S^C.	8'0·8'0	56	Do.	306
B 1	12'0·11'0	135	Do.	1148
B 2	10'0·7'9	77·	Do.	654
B 3	10'0·7'9	77	Do.	654
L	2'6·3'6	8	Do.	74.

TOTAL CUBE.
8725. FEET.
EACH COTTAGE.

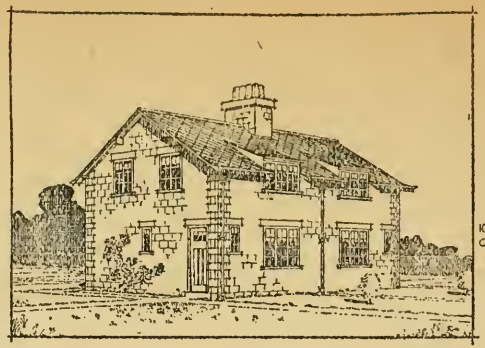
FIG. 113.—DESIGN NO. 124. BY AUSTIN VERNON.

£125 CONCRETE COTTAGES

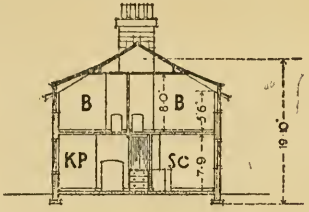


FRONT ELEVATION

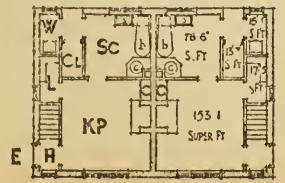
BACK ELEVATION



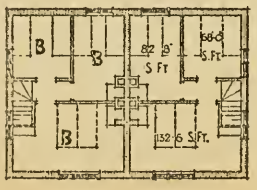
SIDE ELEVATION



SECTION

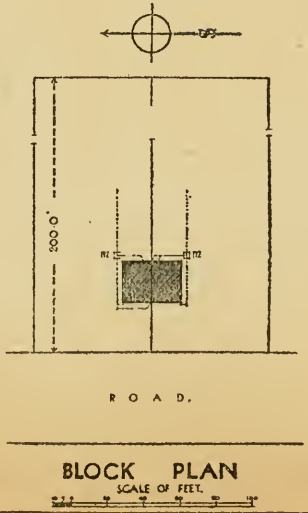


GROUND PLAN

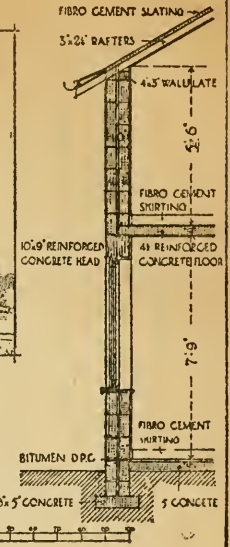


BEDROOM PLAN

SCALE OF FEET



BLOCK PLAN
SCALE OF FEET.



DETAIL OF EXTERNAL WALL

SCALE OF FEET

ROOM	PRINCIPAL DIMENSIONS.	SUPERFICIAL AREA	HEIGHT	CUBIC CONTENTS
KP	12·6 x 12·3	153·1	7·9	1186
Sc	9·0 x 8·6	76·6	7·9	593
B	12·4 x 9·6	132 0	8·0	973
B	11·7 x 7·1	82·0	8 0	618
B	8·6 x 8·0	68·0	8·0	501
L	6·4 x 2 9	17·5	7·0	122
W	5 6 x 2 9	15·1	7·9	117
CU. CONTS. 15091 @ 4d				£251 10 4

TABLE OF SIZES

FIG. 114.—DESIGN NO. 238. BY R. J. MCBEATH.

OTHER DESIGNS.

DESIGN BY MR. ARNOLD MITCHELL.

On the two following pages are given illustrations of a well-planned cottage designed by Mr. Arnold Mitchell, to be executed in concrete, and in view of the careful consideration given by him to the question of workmen's dwellings this design will be of particular interest and value. Plans, elevations, sections and perspective view are given, together with a complete specification for the work, which will give all the information as to the materials and methods to be adopted.

As will be seen by the perspective view, the design possesses considerable architectural merit, achieved by good proportion and simplicity, and there is no attempt to provide ornamentation which is out of place in a building of this class.

The plan is simple and straightforward, with no waste of space, and the accommodation is adequate and no more, thus ensuring the lowest possible cost in erection. It will be noticed that a parlour is provided in addition to the living room, this being absolutely necessary, in Mr. Arnold Mitchell's opinion, such opinion having been formed after many years' experience. and he considers that it is one of the essentials of the problem, because it is impossible to satisfy even the humblest occupant without this being incorporated in the design. He also considers that the addition of a bath-room, bay window, or rather larger accommodation with the consequent increase in price, and naturally higher rent, will not be justified, as there are very few working men who will care to pay even a small increase in rent when such additional accommodation is given. The rent is obviously the crux of the whole problem, and the design is worthy of a great deal of consideration as emanating from one who may be considered as an authority on the subject.

SPECIFICATION FOR MR. ARNOLD MITCHELL'S PAIR OF COTTAGES.

A water supply must be available for use of Contractor.

Contractor to give all notices, comply with regulations of Local Authorities, and pay all fees that may be legally demandable.

Contractor to be responsible for correct setting out of work, which is to be of the best ; to find all labour, plant, scaffolding, etc., and materials as specified.

Contractor to insure against fire throughout progress of works for full amount of Contract, and to deposit policy with Building Owners. He is also to be responsible for all claims under Employers' Liability (Workmen's Compensation) Acts, and also for damage done to adjoining property or person by his workmen.

Contractor to remove all plant, rubbish, etc., and leave all clean, complete, and ready for occupation.

EXCAVATION.

Level site, excavate surface earth to a depth of 7 ins. over area of cottage, excavate for foundations to a depth as shown on drawing, and deposit and well ram surplus earth from trenches to make up levels under floor of cottage so that when finished the same is 6 ins. above ground. Lay 4 ins. of broken brick rubble over the whole area of floor space, well rammed.

CONCRETE.

Concrete to be mixed in proportion of one part of Portland cement to eight parts of clean ballast or other suitable hard material, with due proportion of sand. That in foundations of external walls and under chimney breasts and party wall to be 8 ins. thick. Lay a concrete raft 6 ins. thick over entire internal area of cottages, where to parlour and living room the top 1½ ins. of this to be composed of one part of Portland cement to eight parts of breeze.

Finish surface concrete to entrance lobby, space under stairs, larder and wash-house with cement floating 1 in. thick as paving, composed of one part of cement to three parts of sand, and trowelled to even surface.

Lay space at rear as shown, also under closets, with concrete 6 ins. thick, spade-levelled on top to falls. Floors of closets to be laid to a sharp fall to doorway.

To face p. 140.

To face p. 140.

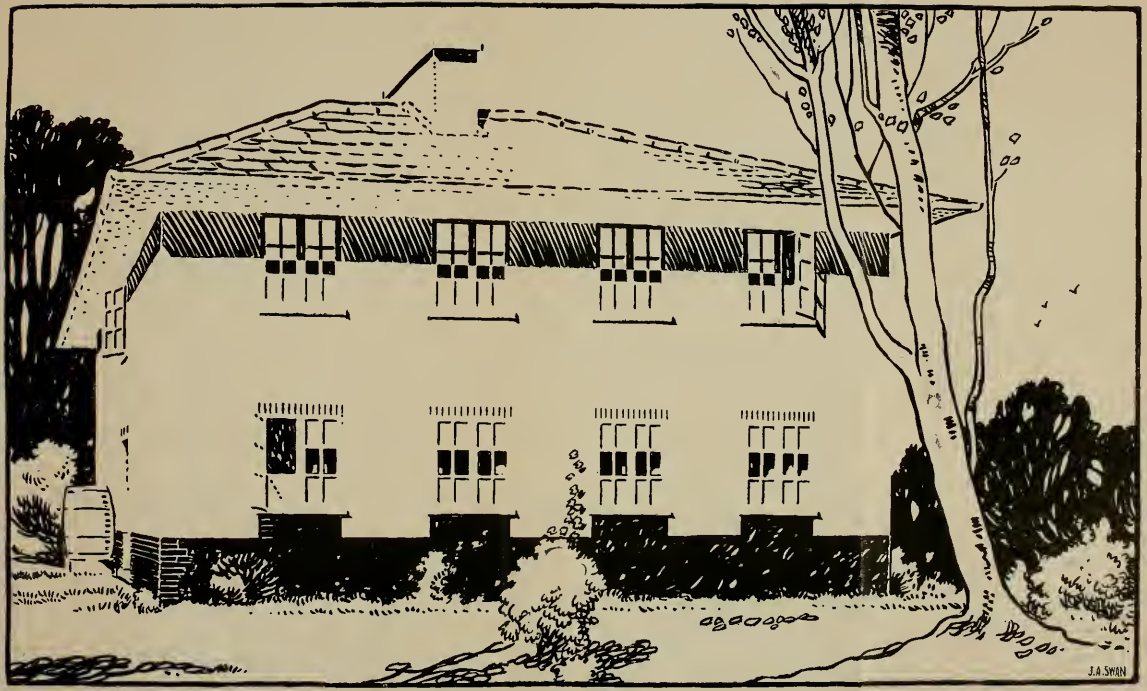


FIG. 115.—ELEVATION OF COTTAGE DESIGNED BY MR. ARNOLD MITCHELL.

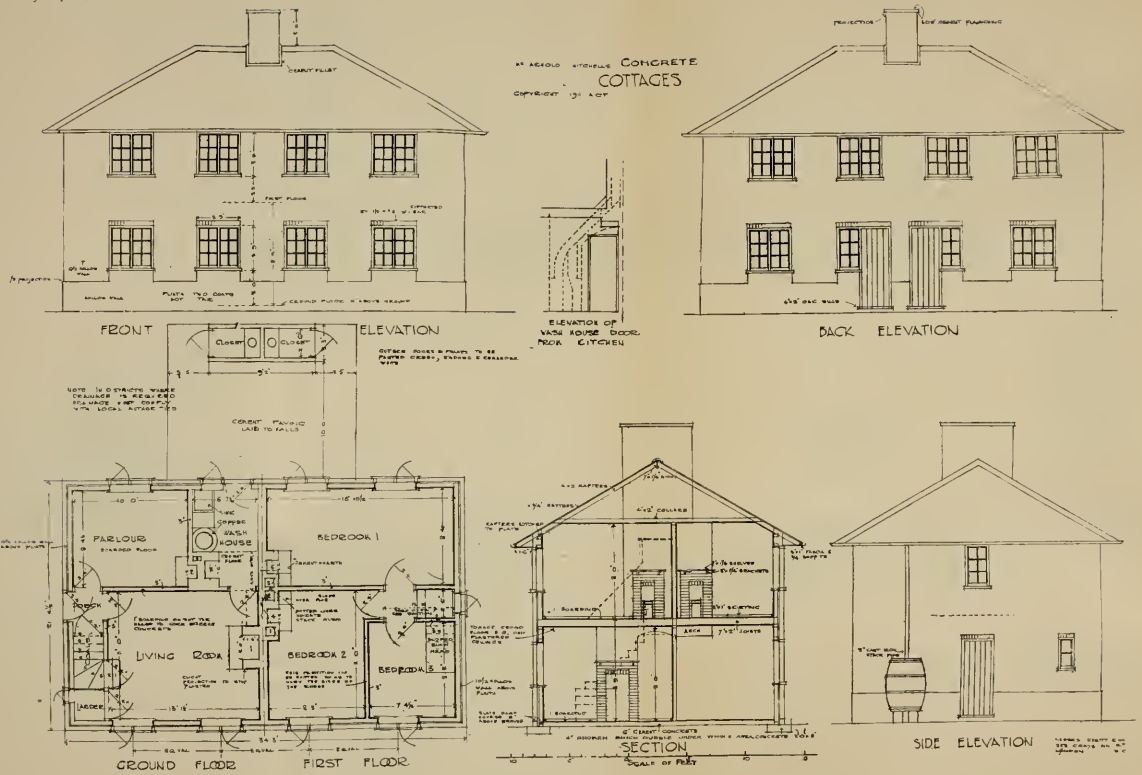
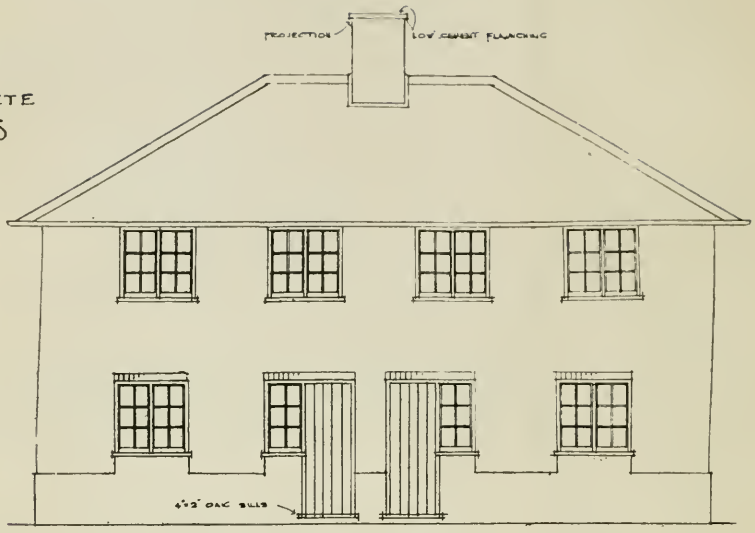
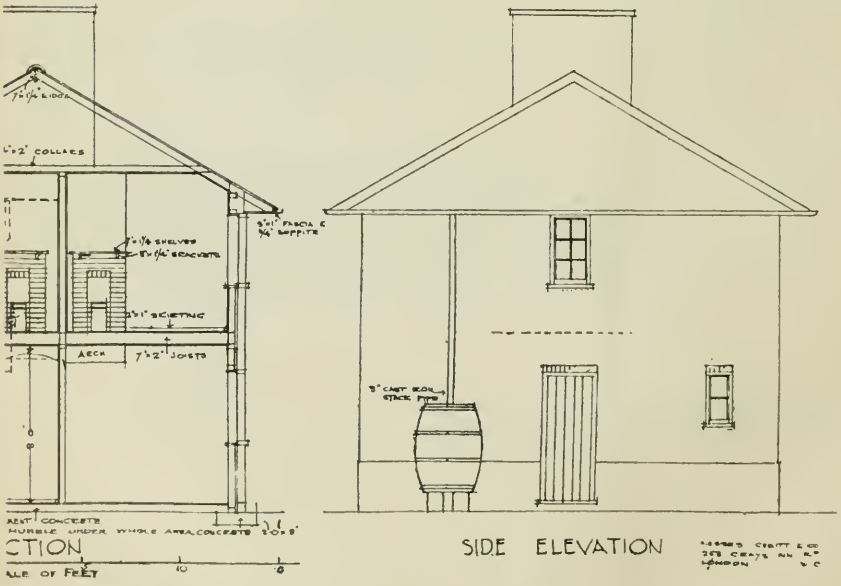


FIG. 116.—ELEVATIONS AND PLANS OF COTTAGE DESIGNED BY MR. ARNOLD MITCHELL.

ONCRETE
TAGES



BACK ELEVATION



NED BY MR. ARNOLD MITCHELL.

Form concrete trimmer arches 3 ins. thick to hearths of bedrooms and finish all hearths with a cement floating as before described to pavings.

WALLING.

Walling is to be throughout of concrete blocks made on one of the ordinary concrete block-making machines. The most satisfactory surface externally for the concrete blocks is that obtained by using flat plain plates in the box of the machine, any attempt at imitation of stonework is to be deprecated. The outer half of the external hollow wall to be of concrete blocks of the finest possible quality made with washed shingle and Portland cement six to one, with one of sand added. The inner half of the external hollow wall and all internal partition walls to be of coke breeze and Portland cement six and one.

Mortar to be composed of one part cement to three parts of clean sharp sand.

External walls to be built hollow in two 4½-in. thicknesses, stretcher bond with 1½-in. space between, the lower portion to have a 2-in. space to form ½-in. external projection as plinth. Wall heads to be filled solid as shown. The two thicknesses of hollow walls to be tied together with three iron ties built into every yard super of area.

The internal partition walls to be 3-in. concrete slabs, and the wall to closets to be 4½ ins. thick.

Damp courses to be Callender's pure bitumen sheeting or of slates in cement. Damp courses to external walls are not to run through cavity, and that to outer casing to be two courses high above ground and to inner casing one course above ground.

Build chimney stack as shown of brickwork, top course to be built oversailing in cement mortar and finished with a shallow cement flaunching. Flues to have regular and easy bends. Core all flues at completion.

Finish plinth externally with two coats of hot tar.

Build in fixing slips to all openings as work proceeds.

Supply and fix 1½-in. by ⅜-in. flat chimney bars to all fireplace openings; also similar bearing bars over all external door and window openings.

In external wall of bedroom No. 3, where shown near ceiling, provide and build in air grating, to approval of Local Authority, and leave opening behind sanitary pail at floor level in earth closet for ventilation.

Build 9-in. brick jambs and frieze of pickled bricks to all fireplaces, slightly projecting in front of walls to stop plaster and neatly pointed.

Properly set stoves and ranges in good hard fire-resisting bricks, and neatly render in cement around backs and sides of openings.

Provide the p.c. sum of £4 1s. (pre-war price) for the two cottages for hob grates and ranges, to be obtained from Messrs. Wing & Webb, of St. James Square, Wolverhampton.

Fit up copper with galvanized iron pan set solid in brickwork, connect to flue, and provide and fix furnace work, cast-iron damper and frame, etc.

In wash-house of each cottage provide and fix on iron cantilevers cast concrete sinks of best quality, or alternatively cane in and out glazed stoneware sinks, with glazed stoneware waste pipes to discharge into pail under; outlets to be fitted with hard wood plugs.

Provide and stand under each sink a galvanized iron pail with handles.

TILER OR SLATER.

Cement concrete tiles made by one of the tile making machines, wired every third course to the roof battens, make the best roof; failing this, cover roofs of cottages and closets with Countess slating gauged to a 2½-in. lap, and each slate fixed with two zinc nails on 1-in. by ¾-in. sawn battens, with double course of slates to all eaves, and verges bedded and pointed in cement.

Cover ridges and hips with half-round ridge tiles set and pointed in cement, and run cement fillets around base of chimney stack and at top of lean-to over closets.

Leave roofs sound and perfectly watertight at completion.

CARPENTER.

All deals, battens, boards and other timber to be good yellow deal of " thirds " quality for carpenter's work and " seconds " quality for joiner's work ; all clean, sound, dry and free from defects.

Oak to be of English growth, clean, close grained and well seasoned.

Provide and fix 4-in. by 3-in. fir lintels over openings in brick on edge walls, also to support inner casing over openings in hollow walls, except to wash-house, which are to be 6 ins. by 3 ins. Lintels over doors to closets to be 4½ ins. by 3 ins.

The faces next rooms to be wrought and kept flush with the plaster, etc.

Joists to first floor to be 7 ins. by 2 ins., not exceeding 16-in. centres. Wall plates to be 4 ins. by 3 ins.

Properly trim for hearths and round chimney breasts and to stairs, and fix boarded centering for concrete trimmers to hearths. Trimming joists and rafters to be ½ in. thicker than ordinary.

Roof over cottages to be constructed as follows :—Plate, 3 ins. by 2 ins. ; rafters and collars, 4 ins. by 2 ins. ; ridge and hips, 7 ins. by 1¼ in.

Roof over closets to be constructed with 3-in. by 2-in. plates, rafters and ceiling joists.

Rafters and collars not to exceed 14-in. centres.

Finish eaves with 1-in. by 3-in. fascia, and ¾-in. boarded soffit beneath feet of rafters. Alternatively lath and cement underside of eaves.

Construct timber partitions to bedrooms, first floor, with 3-in. by 3-in. heads, cills and posts, and 3-in. by 2-in. studs, 14-in. centres.

JOINER.

Lay 1-in. well seasoned flooring to whole of first floor and to living room and parlour, well cramped and nailed. That to living room and parlour to have surface concrete under, well tarred, and to be bedded in hot tar and nailed to breeze concrete. Fix ¾-in. by 2-in. chamfered skirtings to wall lines of all wood floors, well nailed and plugged to walls.

Fix to all window openings rebated frames and mullions out of 4-in. by 2½-in. yellow deal, with 5½-in. by 2½-in. deal sunk, weathered and throated cills.

Casements to have 1½-in. by 1½-in. stiles and top rails, 1½-in. by 3-in. bottom rails, and 1½-in. by 1½-in. bars.

All sashes and frames to be properly tenoned and wedged together and framed square.

Casements, where shown to open, to be hung with 2-in. cast-iron butts, and to have steel casement stay and wrot Cockspur fastener. (These are included in provision for Ironmongery, see on.)

Provide to all window openings 1-in. linings, tongued to frames and finishing flush with plaster, with slightly rounded edge and quirk in plaster to form a V joint.

Fix 1¼-in. window boards, with rounded nosings, to project ½ in. in front of plaster.

Front entrance doors and doors from porch to parlour and living room to be ledged, covered with 1½-in. matched and V-jointed battens, with three ledges to each, hung on strong strap hinges. Front doors to have 2½-in. by 4-in. rebated frames, and 4-in. by 2-in. oak cills and deal linings as to window cills to be kept 2 ins. above floor. Parlour and living room doors to have jamb linings, with stop nailed on and slightly rounded both edges, with a quirk in plaster to form V joint.

External door to wash-house to be all as to front entrance, but covered with 1-in. boarding, also doors to closets, but without oak cill.

Door under stairs to be all as to parlour and living room, but covered with ¾-in. boarding. All other doors to be similar, but covered with 1¼-in. boarding.

Form enclosure between staircase and larder, and enclosure to staircase on first floor, and false ceiling over stairs with ¾-in. matched and V-jointed boarding, with 2-in. by 2-in. studs and rails.

Fix three 1-in. wrot shelves on 3-in. fillets in each larder, and 1¼-in. mantel shelves and brackets, as shown, to fireplaces.

Fix a wide 1¼-in. shelf in wash-house on proper fillets and legs for washing-up purposes.

In living room of each cottage, at side of fireplace, fit up a dresser 6 ft. 6 ins. high, with 1-in. top to lower part with two drawers under with turned knobs, and with 1-in. cut and shaped ends to upper and lower parts, and with one 1-in. central division below top, and fitted above with two shelves sunk for plates, with brass cup hooks on edges, and with 1-in. top with small cornice planted on.

Form staircases with 1¼-in. treads, with rounded nosings and ¾-in. risers, and all properly tongued, fitted, wedged, glued and blocked together, housed at ends to 1¼-in. strings.

In closets fit up 1-in. deal ledged seats, with cut and dished holes, on strong bearers. Provide and place under same galvanized iron pails with handles; work in closets as to house.

Provide 1-in. deal lids with shaped handles for coppers.

To each cottage, under rain-water pipe, provide a clean butt to hold not less than 100 galls., with draw off tap and cover, on strongly built concrete supports.

Provide the p.c. sum of 40s. (this is pre-war price) for pair of cottages for all ironmongery to doors and windows, including screws, from Wing and Webb, and fix complete.

SMITH.

To eaves of roofs fix 4-in. cast-iron half-round eaves gutter on brackets, screwed to fascia, joints made with red lead putty. From same to discharge into each rain-water butt run 2½-in. cast-iron down pipe, with approved clips and ears. No eaves gutters to roofs over closets.

PLASTERER.

Render all internal wall surfaces (except those to larders, under stairs, wash-houses and closets) with one coat of lime and hair finished with a wooden float.

Lath all ceilings of cottages, also partitions first floor, with stout sawn laths, clean and free from sap, and properly nailed, and render same as to walls.

No ceilings to closets.

GLAZIER.

Glaze all windows with 15-oz. clear glass, well puttied and back puttied and left clean at completion.

PAINTER.

All painted work to be thoroughly rubbed down and stopped. All white lead to be genuine old lead.

Twice distemper white all ceilings and plastered and internal brick walls.

Paint all ironwork one coat of genuine red lead paint before fixing and three coats of best oil colour after fixing.

Knot, stop, prime and paint with three coats of best oil colour all doors, windows, frames and other woodwork.

Paintwork to be finished white except doors, gutters, down pipes and rain-water butts; these a bright green.

All internal woodwork (other than treads and risers of staircase and shelving) to be stained with green or brown stain, and once varnished.

Black stoves and ranges.

Attend upon, cut away for and make good after all trades, clean floors, glass, &c., and leave all perfect at completion.

NOTE.—Where work is shown on Drawings and not described in Specification it is to be carried out and *vice versa*, and all work that is reasonably to be inferred from both Drawings and Specification, though not particularly shown or described on either, that is necessary to make the building habitable and complete is to be included and is to form part of the work for which the Contractor is responsible.

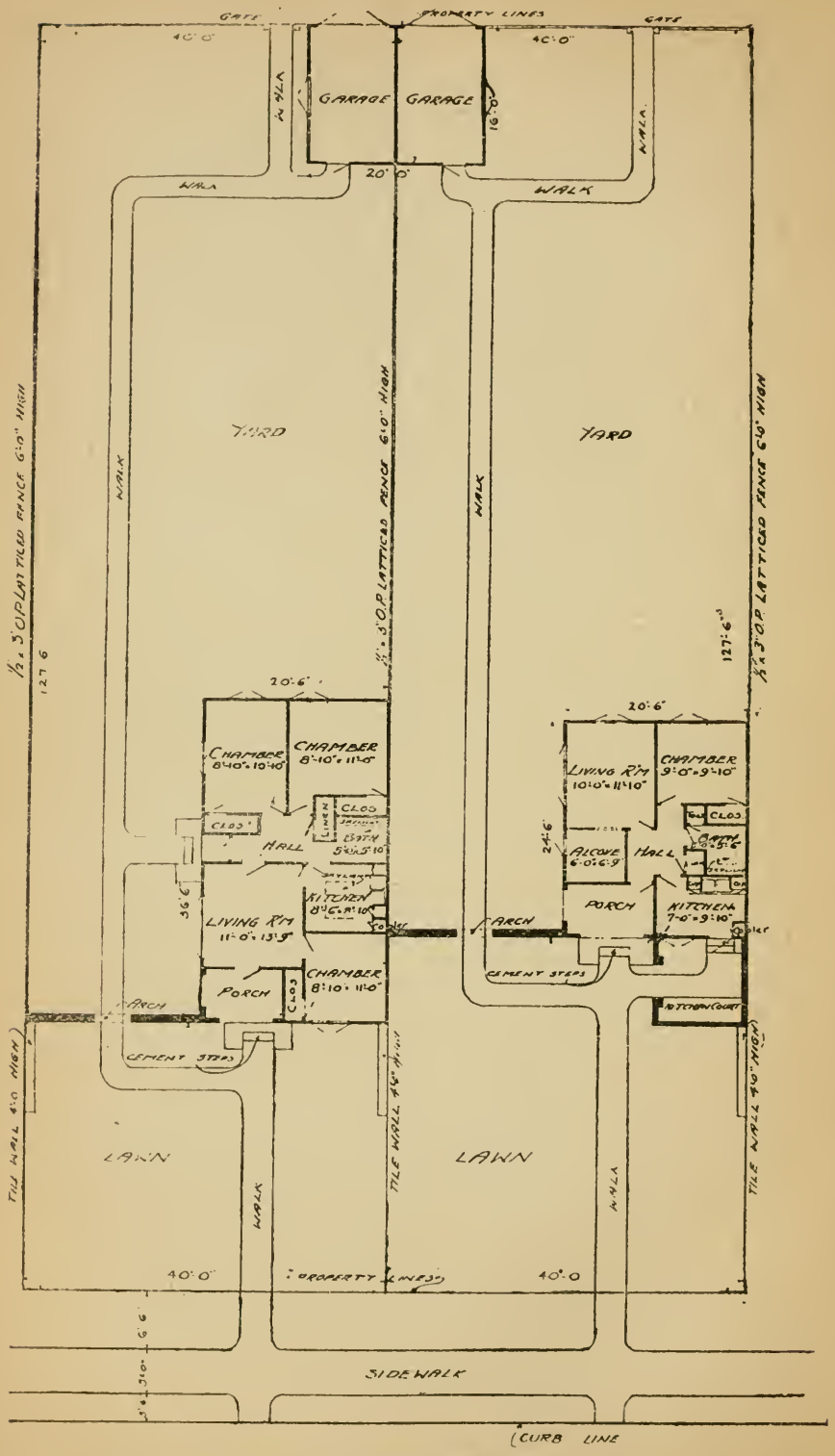


FIG. 117.—PLANS OF COTTAGES BY MR. IRVING J. GILL.

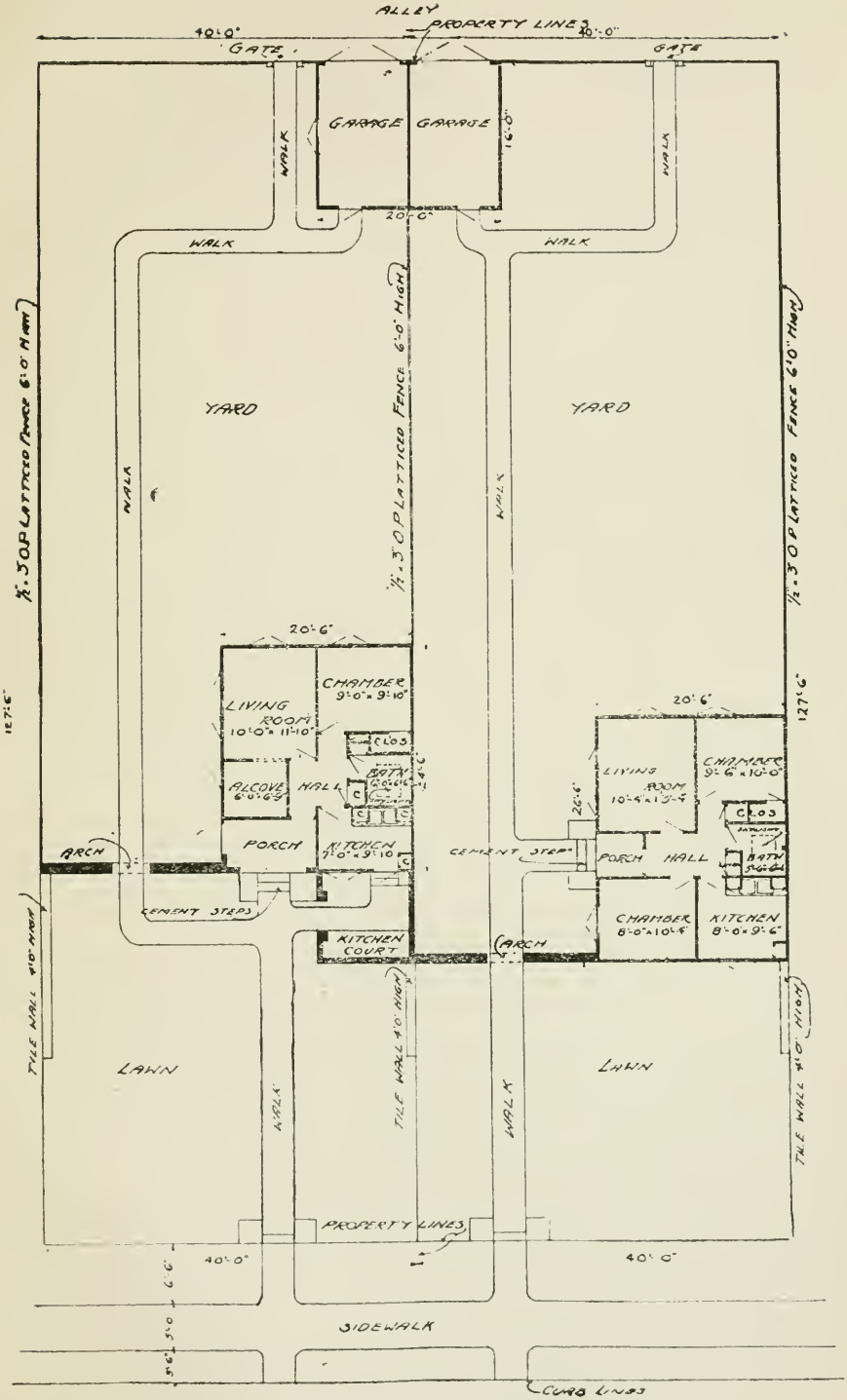


FIG. 118.—PLANS OF COTTAGES BY MR. IRVING J. GILL.

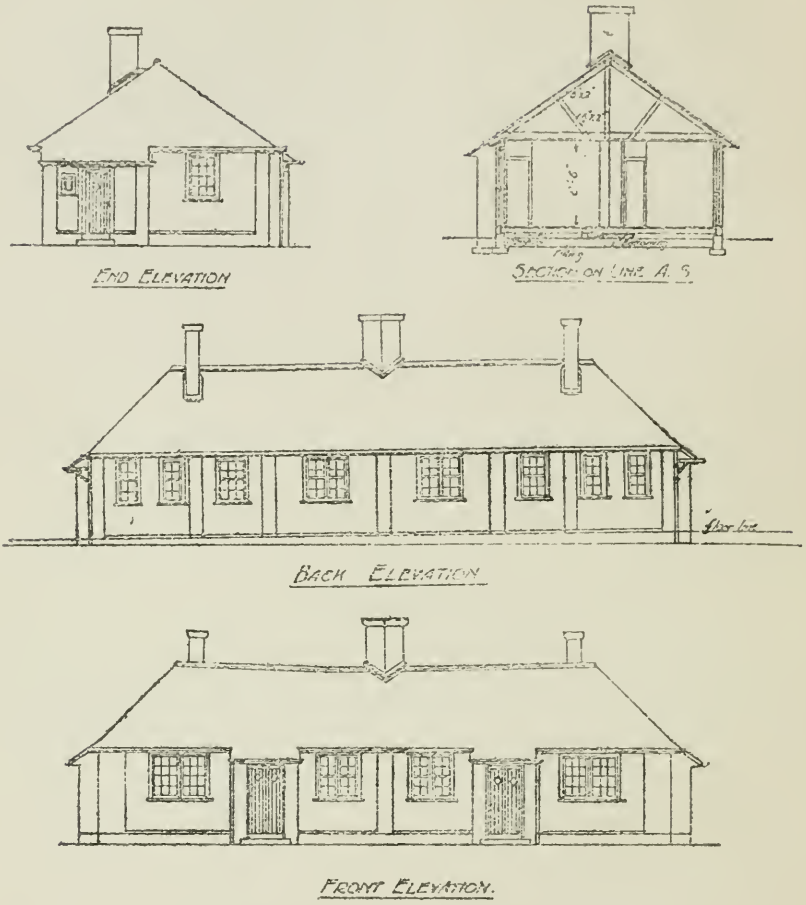


FIG. 119.—DETAILS OF COTTAGES AT INVERGORDON.

FIG. 120.—COTTAGES AT INVERGORDON.

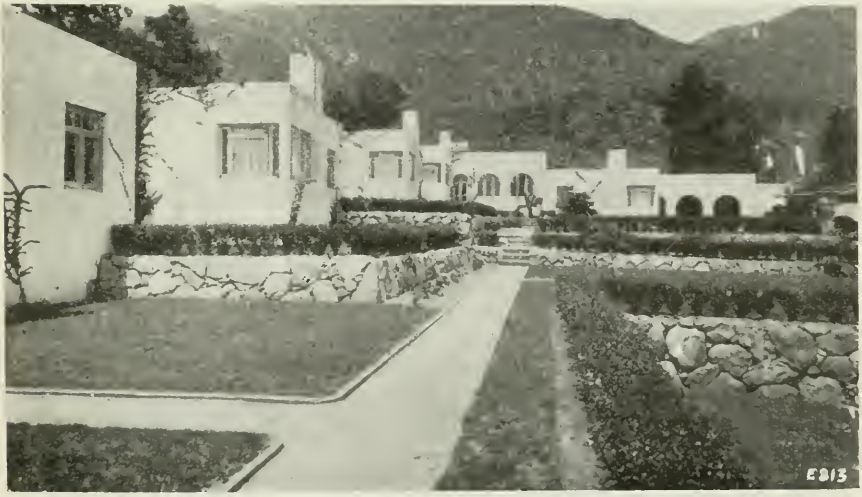


FIG. 121.—A GROUP OF COTTAGES DESIGNED BY MR. IRVING J. GILL.

FIGS. 122, 123 AND 124.—COTTAGES DESIGNED BY MR. IRVING J. GILL.

FIG. 125.—BUNGALOW OF CONCRETE BRICKS.

FIG. 126.—A DOUBLE WALL COTTAGE.

Housing Scheme, Invergordon.

The photograph and drawings illustrated in Figs. 119 and 120 show some concrete cottages that are being executed at Invergordon for the Edinburgh Local Government Board under a new housing scheme. These are constructed as semi-detached bungalow cottages, having a living room, three bedrooms, scullery with copper, and a combined bathroom, and w.c. The walls are built with concrete blocks, and the appearance is simple but effective, while the example is particularly interesting as showing quite recent work executed under war conditions.

Cottages, Chepstow.

The cottages illustrated in the frontispiece form one block of many which are under construction for a shipbuilding and engineering company at Chepstow (Mon.), from the designs of Messrs. Dunn, Watson & Curtis Green, 35, Lincoln's Inn Fields.

This block contains five cottages and they are an excellent example of successful design in concrete. The clients have shown the most commendable spirit in this scheme, as they have spared no effort to make the cottages models of good building with ample accommodation and artistic appearance.

The site is a very picturesque one, in a valley outside the ancient walls of the town, and as the contours of the ground are very irregular the design of each block has been varied to suit its particular position, while the prospect and aspect has been carefully studied in each case.

The difficulty of getting bricks and the presence of good material for concrete led to the adoption of concrete blocks for all walls and partitions. These blocks are made on " Winget " machines, and the external facing blocks have a droved surface. The general texture and colour of these external walls is very pleasing and the effect, when seen, would remove the prejudice that exists among many designers against the appearance of concrete as an exposed surface. External walls are constructed as cavity walls with two thicknesses of 4-in. blocks, having a 3-in space between, and iron ties as usual.

The accommodation varies in each house, but in those illustrated there are in each of the five houses in the block, a parlour, three bedrooms, kitchen, scullery, bathroom, fuel store, larder and front and back porches. The backs of the houses have been studied as much as the front and the effect is equally pleasing. The roofing is of sand-faced tiles with swept valleys and plain roll ridges.

The builders of the block illustrated were Messrs. J. W. Falkner, London.

Designs by Mr. Irving J. Gill.

The successful application of concrete to domestic work is very well illustrated in the designs by Mr. Irving J. Gill, an American architect, who has studied the possibilities of the material for some time, and who has succeeded in producing some excellent effects, as will be seen in the photographic views, Figs. 121, 122, 123 and 124.

Concrete is used exclusively for the construction, the walls being cast, each in one piece on an inclined table and afterwards raised to the vertical position by means of jacks. The designer relies entirely on the proportion and grouping of the various parts for his effects, and large plain surfaces are conspicuous in each building. Arches are also greatly used and the roofs are constructed as flats with large overhanging eaves or with plain parapet walls. Woodwork has been eliminated whenever possible and steel is used for door and window frames, while architraves, skirtings, picture rails, chair rails and similar features are dispensed with and a good hard cement plaster is adopted for all positions where rough usage is possible. The plastering used is the very best quality, and the interior walls are generally finished with soft white or neutral tints, which reflect a certain amount of colour from the curtains, rugs, and other furnishings. The floors in many cases are finished in cement, these being specially treated with colour and oil to produce a good appearance, and wood floors are seldom adopted even in the larger types of buildings. The plans illustrated will be seen to be somewhat unusual, as the kitchen is generally placed in the front, but this is shielded by the walls of the

kitchen court, and it has the advantage that the rear garden is kept free from tradesmen and rendered private for the use of the owner. Great use is made of shrubs, trees and creepers to produce exterior effects, and these designs are undoubtedly some of the most successful examples of complete concrete buildings in existence, while they show the possibilities of the material in a very striking manner.

Double Wall Bungalow and Cottage of Concrete in U.S.A.—Two other examples of American concrete domestic work are illustrated in Figs. 125 and 126. The first example shows a bungalow in which the walls are built with concrete bricks, these being used in two leaves with a 1½-in. air space between and forming a wall 9 in. thick. The exposed bricks are faced with a mixture of 1 part Medusa white Portland cement and 1½ parts coarse washed sand. These were brushed to give a rough texture on the face. The body portions of the faced brick and the bricks for the inner leaf are made with 1 part grey cement, 2 parts sand, and 3 parts gravel, and they are laid in mortar of equal parts of lime and grey cement mixed with sand. The mortar was raked out of the joints to a depth of ½ in. on all exposed faces, and plastering was applied directly to the inside surface of the inner leaf. The second example illustrates a cottage in which the walls are also hollow concrete, there being two thicknesses each of 4 in. and a 2½ in. cavity, constructed on the monolithic principle, even the chimneys up to the roof level being cast in concrete. The exterior has been treated with stucco and the inside walls are plastered. The designs are quite pleasing and good examples of two distinct types of concrete construction.

CHAPTER V.

TILES AND FENCE POSTS.

HOW TO MAKE CONCRETE ROOFING TILES.

Materials.

The most suitable material for the manufacture of concrete roofing tiles is sharp sand, but finely crushed clinker, free from all dust and impurities, has been used with success, and has in its favour the fact that it makes a lighter tile than sand, or other aggregate.

Grading Materials and Mixing, &c.—The aggregates for concrete roofing tiles must be clean, free from loam, sulphur, and all other impurities, such as are referred to in the notes on Concrete Blocks.

As before mentioned, the most suitable aggregate for this purpose is sand. If from a pit, it should be well washed, to free it from every article of loam it may contain. It should be a good, coarse, sharp sand, and should pass a $\frac{1}{8}$-in. mesh sieve. If clinker is used it should also pass a $\frac{1}{8}$-in. sieve and must be of very sharp texture, while other aggregates—as, for example, fine granite, fine stone chippings, &c.—would be quite suitable, providing they are quite free from dust and other impurities.

The mixing of the materials for tiles differs somewhat from the mixing for concrete blocks. The proportions are stronger and the mixture is made wetter.

The mixture is composed of $2\frac{1}{2}$ of aggregate to one of cement. After it has been thoroughly mixed, the water should be applied from a fine rose can, and the mixture should be turned about while the watering process is taking place. It must not be made sloppy, but just wet enough so that, when a shovel is drawn over the mixture, the water rises to the top. If the mixture is too wet, the tile will lose its shape upon being taken from the mould, and should it not be wet enough, the tile will be weak when finished. But the right consistency will soon be found after one or two experiments and tests, and this is one of the best ways of gaining experience, providing one has sufficient knowledge to undertake the tests in a proper manner.

Machinery and Moulds for the Manufacture of Concrete Roofing Tiles.

Machines and moulds for roofing tiles are of a somewhat different construction to the machinery and moulds used for concrete block making, and so a detailed description is necessary.

As there are several types in common use in this country, it will be well to take the general principle upon which all tile machines are made.

In Fig. 127 a general view of a roofing tile machine is given. *A* shows the mould box in position. *B* is the table to which the mould box is fixed. *C* is the

guide for the strickle or striker which forms the top of the tile. *D* is represented by a dotted line, and is the position of the pallet when ready for a tile to be made. E is the handle or lever for raising the pallet and tile out of the mould after the tile is made. This lever is connected to a shaft upon which a crank is fixed,

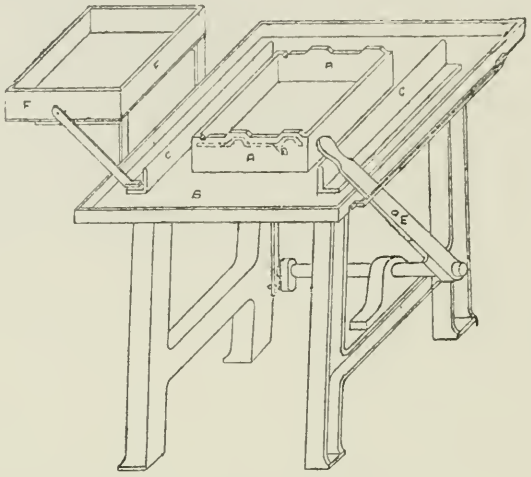


FIG. 127.—A ROOFING TILE MACHINE.

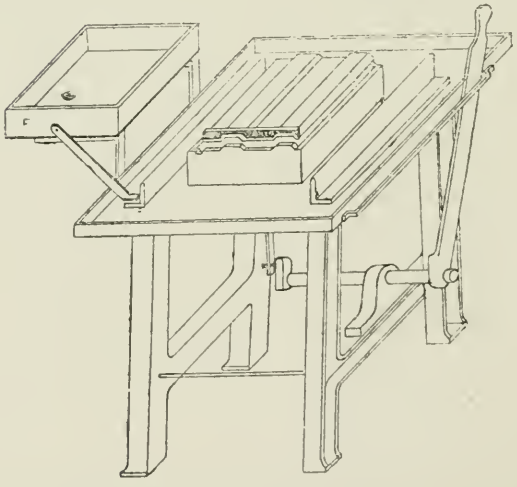


FIG. 128.—SHOWING TILE READY TO BE TAKEN AWAY.

and this raises a plate which has four columns fixed to it. *F* shows the colour box, from which the glazing material is applied, and further reference will be made to the working of the machine later on in these notes.

This illustration is only intended to show the general principle of the working of a roofing tile machine, but there are several different makes of these machines.

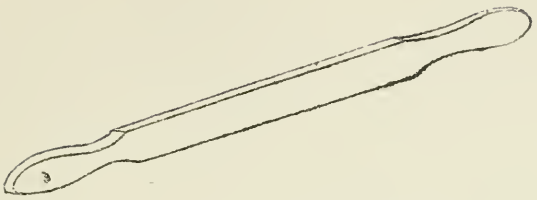


FIG. 129.—STRICKLE OR STRIKER FOR RIDGE TILES.

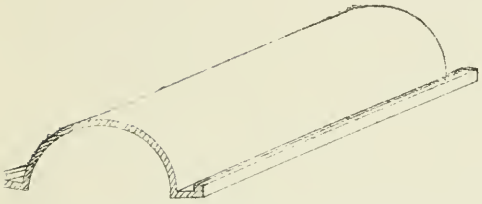


FIG. 130.—PALLET FOR RIDGE TILES.

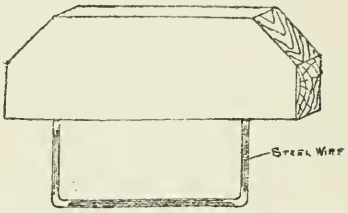


FIG. 131.—COLOUR SPRAYER.

FIG. 132.—SECTION OF TILE SHOWING LOCKING PIECE

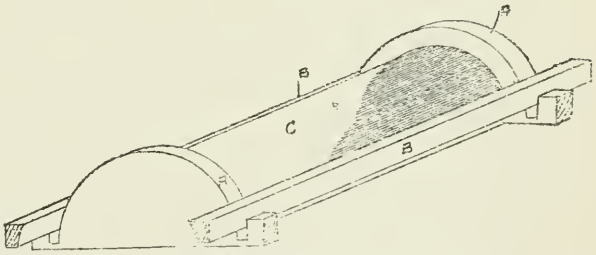


FIG. 133.—MOULD FOR RIDGE TILES.

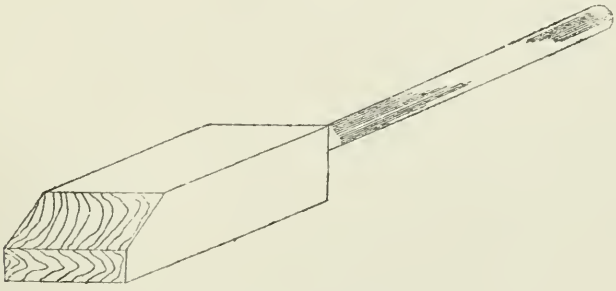


FIG. 134.—TAMPER.

Fig. 128 shows the same machine after a tile has been made with the tile raised out of the mould box ready to be taken and placed upon the racks to dry. Fig. 133 shows a complete mould for making half round ridge tiles. These are made by hand. Fig. 130 illustrates the pallet upon which they are made. Fig. 129 is the strickle, and this works upon the edge of the ends marked *A* on Fig. 133. *C* is the pallet, while *B* forms the thickness of the sides of the tile. The whole of this mould is made of iron. The operation of making the tile is described later on.

Before leaving the subject of machines it would perhaps be well to refer here to the question of the glazing of the tile. To mix the colour and the cement properly it is necessary to mix it by machinery. The machine for this consists of an iron drum, which revolves with a central shaft to which it is fixed. Inside the drum several (turned) iron rollers are placed. As the drum revolves round, the rollers roll round the side of the drum, and grind and mix the colour and the cement together. Of course, the colour and cement can be very well mixed by hand, but this is an expensive method, as the time it takes to get the colour uniform throughout adds exceedingly to the cost of the tile.

Making Concrete Roofing Tiles.

Before dealing with the actual making of the tiles, the mixing of the colour and the cement must be referred to. The amount of colour required for glazing largely depends upon the colour itself, but if light or middle red oxide is used, it will be necessary to mix 1 of colour to about 10 of cement. This can be mixed in a colour machine such as referred to in the last paragraph, or it can be mixed by hand. If it is mixed by hand it will be necessary to sieve it through a very fine mesh sieve, which will greatly help in getting uniformity of colour throughout. It should be noted that the colour and the cement are measured by weight and not by baulk. Now we will assume that all is ready for making the tiles. The colour-box is filled with the mixture of colour and cement. The first operation is to place the pallet in the mould-box, and then shovel some concrete (gauged as before mentioned) on to the pallet. This is tamped down with a tamper, as shown in Fig. 134, which is made of hard wood. Then the strickle is run over the surface of the concrete until the tile is the shape of the strickle and of the required thickness. The thickness must always be the same if the strickle is worked down to the guides, or the tiles will not lay flat or be at all neat when fixed. But with a little practice this is easily done without any special effort. When the tile is of the required shape and thickness, the colour-box is moved from its table on to the mould-box, and the colour is applied. This is done either by giving the colour-box a sharp tap or by drawing a specially bent piece of wire fixed in a handle, and similar to Fig. 131 over the bottom of the colour-box. This will give an even thickness of colour over the surface of the tile. After the colour has been applied the colour-box is removed back on the table arranged for it (the box being so arranged with iron guides that it always fits on the mould-box and upon its table in exactly the same place, so that it is practically an instantaneous movement). Next the strickle is run over the coloured surface, which gives a kind of glazed appearance to the tile. The next operation is to put the top locking-

piece on. For this a small box is arranged to fit over the tile, and this allows the rib to be put on to the tile, as shown in Fig. 132. The box is filled with concrete, and is tamped down, care being taken not to tamp too hard to alter the shape of the tile where the joint is made. The surplus material is scraped off the top of the box, and the box is removed. The tile is then ready to be taken from the mould. To release it from the mould-box the lever *E* is pushed back, and this raises the tile out of the mould. The tile is then resting upon the pallet (which forms the underneath side of the tile, and thus must be the exact shape of the under side of the tile), and this allows it to be "handled" quite easily. It is then taken from the machine and placed upon racks (see Fig. 135), upon which it rests for three days, when it may be taken from the pallet and stacked. It must always be borne in mind that the tiles must be kept from the sun and draughts when they are first made; if not fine cracks will be noticeable on the surface of the tile, and if these should develop the tile will not be waterproof. It may seem to the reader to be a long operation to make these tiles, but after a man has got into the way of making, he will not have any difficulty in turning out 200 to 250 tiles in a day of 10 hours. After the tiles are put into stacks. they should be watered every other day for 10 days to a fortnight. On no account should they be used for at least six weeks or two months, after making.

Figs. 136, 137, 140 and 141 show some different types of concrete tiles in use; while Fig. 142 illustrates, in section, the sideways interlocking of the tile in Fig. 136. Fig. 143 shows how the ends of the same tile also interlock. The benefit of this type of tile is that when a roof is set out and the battens are fixed so as to work the tiles to show all alike, these tiles will slide down, and thus, to all appearances, shorten themselves. This is illustrated in Figs. 144 and 145. Fig. 144 shows the tiles lying on the battens to the full extent of their length, while Fig. 145 illustrates the same tiles on a roof where the length of the rafter will not allow the whole length of the tile to be used, and thus the tiles have either to be cut or shortened in some way or other. In this case, if the tiles were cut, the interlocking and weatherproofing design of the tiles would be destroyed.

When making ridge tiles the mixture is the same as for making roofing tiles, but the operation is slightly different. The material is placed upon the pallet in the mould and is tamped down with a tamper (see Fig. 134). When the material is fairly solid the strickle (Fig. 129) is worked over the surface until the tile is to the shape of the ends of the mould. Then the colouring material is applied from a small sieve and the strickle is again run over the surface. This has a tendency to give a glaze to the surface of the tile. The tile is now finished and the sides *A* and *B* of the mould can be removed, thus leaving the tile exposed and resting upon the pallet. It can then be taken away and placed upon a rack, as before described, until hardened, which will be about three days, and the remarks before made about stacking and using also apply to ridge tiles. Hip tiles are made upon the same principle, but in some cases the designs are slightly different. Figs. 146 and 147 show two types of ridge tile.

It will be found that, where suitable material can be obtained, the manufacture of roofing tiles will be a thorough business proposition, it being possible to com-

pete in price with any clay tile of similar design and then show a good profit for the manufacturer. The weight of a square (10 ft. by 10 ft.) of concrete roofing tiles is about 7 cwt. to 8 cwt., or about 5 to 6 lb. each. Of course different designed

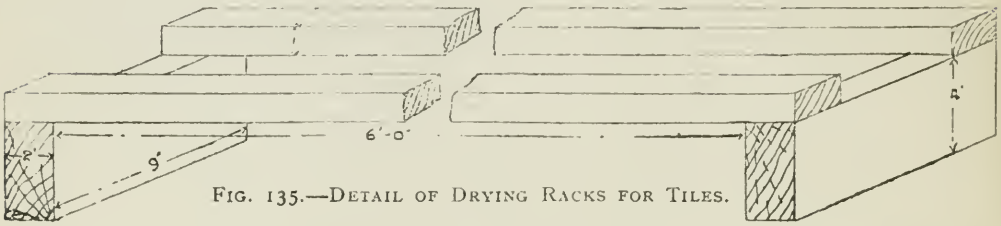
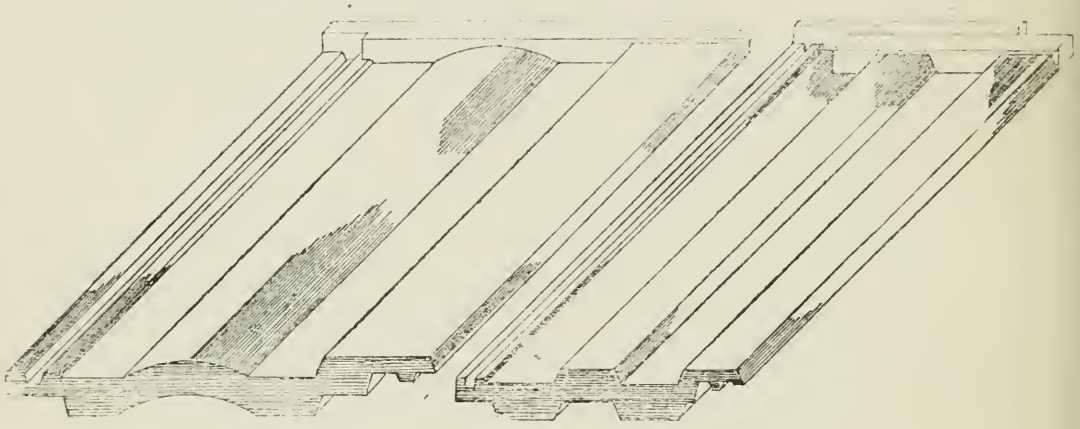


FIG. 135.—DETAIL OF DRYING RACKS FOR TILES.



FIGS. 136 AND 137.—INTERLOCKING TILES.

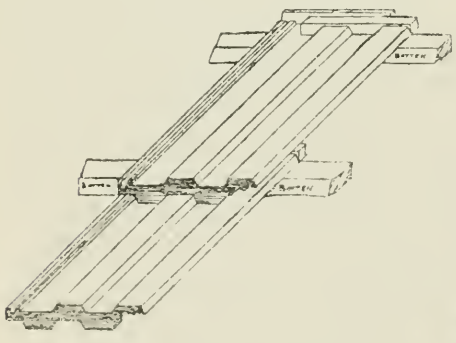


FIG. 138.—BATTEN.

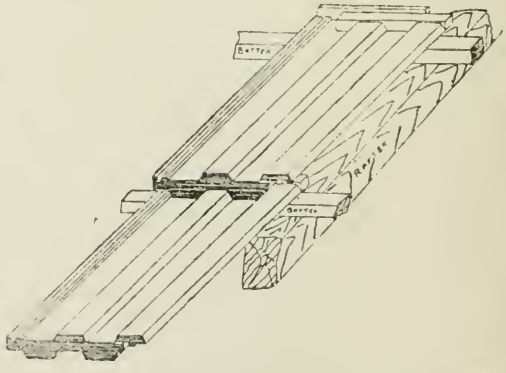


FIG. 139.—TILES AT FULL LENGTH ON BOTTOM.

tiles may weigh more or less, but this is about a fair average of the tiles illustrated in these notes.

The advantages of concrete roofing tiles are that they harden with age, the interlocking and perfect weatherproof design make a neat and sound roof at a

minimum outlay. Being lighter than clay tiles or slate when fixed in position, it is possible to do with less rafters than are usually used for slates or clay tiles, and

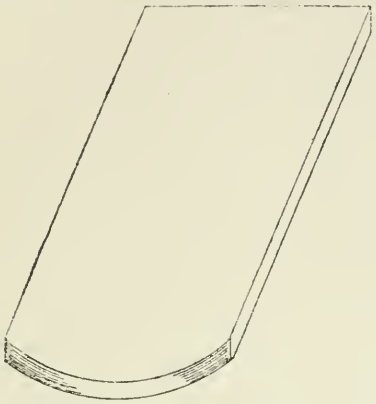


FIG. 140.—TYPE OF CONCRETE TILE.

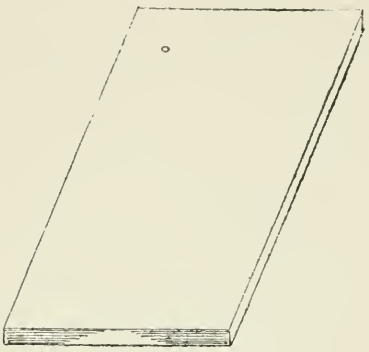


FIG. 141.—A SWEDISH CONCRETE TILE.

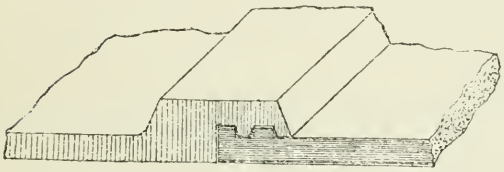
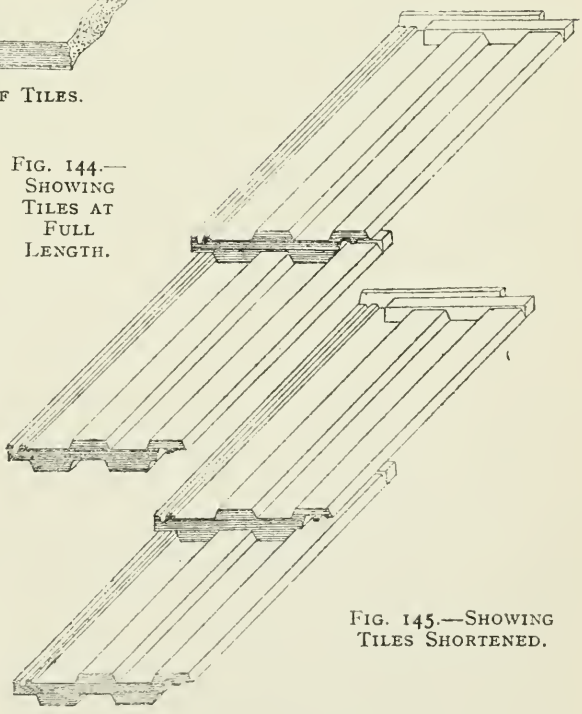


FIG. 142.—CROSS SECTION OF TILES.

FIG. 144.—SHOWING TILES AT FULL LENGTH.



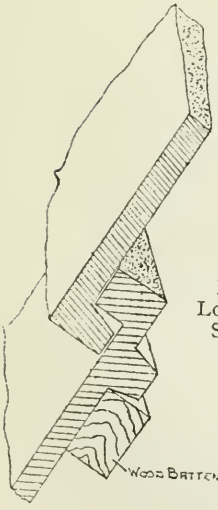


FIG. 143.—LONGITUDINAL SECTION OF TILES.

FIG. 145.—SHOWING TILES SHORTENED.

thus a further saving is effected. Many roofs in different parts of the country have been roofed in with concrete tiles, and have been very successful in all ways, as regards cost, appearance, and also strength.

Concrete Flooring Tiles.

For making concrete flooring tiles which have a flat surface and are one colour throughout, a machine similar in general detail to the one shown in Fig. 127 is suitable. A different mould box must be fitted to the table of the size required for the tiles. This mould box should have cuts in it so that steel cutters may pass through to form half quarters and half diagonal tiles. This obviates a lot of cutting when fixing the tiles and also saves unnecessary waste.

The mixture for flooring tiles requires to be a little stronger than that for roofing tiles, as hard wear has to be taken into consideration. With roofing tiles it will be noticed that only the face surface of the tiles is coloured, but owing to the greater wear it is necessary to colour flooring tiles throughout. The surface of the flooring tiles is finished in exactly the same way as described for the making of roofing tiles.

It must always be remembered that the colour must be mixed with the sand

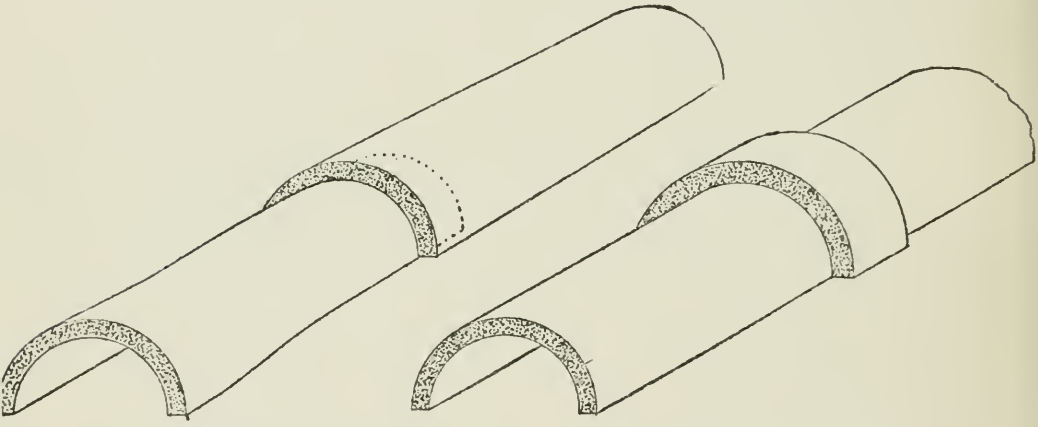


FIG. 146.—RIDGE TILES INTERLOCKING.

FIG. 147.—RIDGE TILES WITH LOOSE PIECES FOR COVERING JOINT.

before adding the cement. Then take 2¼ of coloured sand and mix with 1 of cement. A weaker mixture should never be used as the tiles would soon show the wear. It should be noted that the materials for flooring tiles must be clear and sharp, free from loam, dust, or other impurities such as have been referred to earlier. A knife is used for glazing or finishing the surface of the tile. This knife is made of polished steel. After the tile is made it is placed upon the drying rack (see Fig. 135) and left to harden off. When hardened off it can be stacked and well watered. Fig. 160 gives a view of a pile of racks with the tiles lying on them hardening off. With this method of arranging the racks no time is wasted as would be the case if fixed racks were used. When racks of this type are used, they can be placed around the machine and filled up, and time is thus saved walking to fixed racks and back.

It will also be interesting to add that after the tiles are hardened off, if they are placed in a tank of water for a few days this will greatly increase their strength.

Concrete Mosaic Tiles.

The subject of concrete flooring tiles would not be complete without dealing at some length with concrete mosaic tiles, which are of more variety, especially in colour, and look altogether a better article than the ordinary flooring tile. They can be made to any shape, size or thickness, and with as many different colours on the surface of the tile as may be wished for.

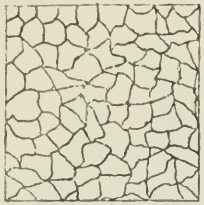
These tiles are not made in a machine as described for the ordinary flooring tiles, but are made on a press which may be worked by hand or by hydraulic pressure or by mechanical means. So long as sufficient pressure is obtained the make of the press is immaterial. Some makes of concrete mosaic tiles are rough, or are made to represent Terrazza flooring, which is laid *in situ*. The usual size for mosaic tiles is 8 in. by 8 in. by 1 in. Illustrations of mosaic tiles are given in Figs. 148 to 153, and some of the different parts for making these tiles are shown in Figs. 154, 155, 156, 157 and 158.

Fig. 154 shows the plate which forms the face of the tiles, and which is known as the "matrix." Fig. 155 illustrates the part which is known as the "stencil." Figs. 156, 157 and 158 illustrate the sieves, and it must be noticed that some parts of the sieves are "blind." This will be explained later on. Fig. 159 shows the die plate which forms the underneath side of tiles, but which is the top while being pressed. In making the tiles, first take the three-coloured tile as shown in Fig. 151.

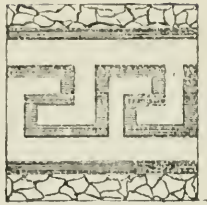
After the colour has been mixed thoroughly with the cement, the mixture should be sprinkled with a little water just sufficient to keep it from "dusting." If a handful is dropped this watering will prevent the dust from flying about. This is a very important feature. The top mixture of ordinary concrete, gauged semi-dry, should be composed of 2½ of clean, sharp sand, granite, or other suitable aggregate, to 1 of cement. For purposes of illustration we will assume that the tile (Fig. 151) is a three-coloured tile, being red, green, and white. The colours are indicated on the drawing.

Everything being ready for making, the mould box is placed in position on the table of the press. The "matrix" (Fig. 154) is placed face upwards in the bottom of the mould. Next the "stencil" or guide for the colours (Fig. 155) is placed upon the matrix, and the mould is then ready for the colours. The sieve which has the white colour in is placed upon the top of the mould box, the mould box having pins in it so that the sieve may fit on it accurately each time.

The part of the tile which is to be coloured red is left open in the meshwork of the sieve, while the parts which are green and white are blinded, or the meshwork covered, so that no red colour can escape other than through the right part. The colour is released from the sieve by means of the colour scraper, as illustrated in Fig. 131. The stencil guides the colour down on to the "matrix," the divisions keeping the colour to its own particular shape. The green colour is next applied, and after that the white in exactly the same way as the red was done. The stencil is now taken from the mould with care, and the ordinary concrete is filled in on top of the colours, but this must not be done with a shovel or else the colours may become disarranged and intermixed and the whole design spoilt. So another

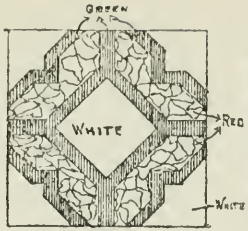


PLAIN TILE ROUGH FACE



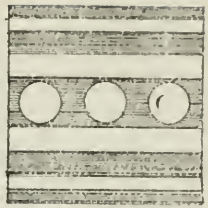
BORDER TILE

TWO COLOUR TILE



THREE COLOUR TILE

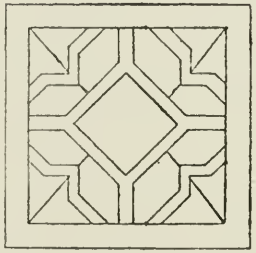
THREE COLOUR TILE



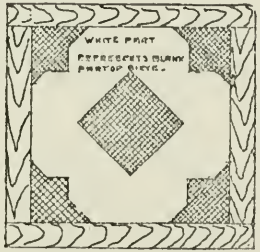
TWO OR THREE COLOUR TILE

FIGS. 148 TO 153.—MOSAIC TILES.

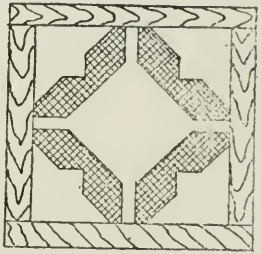
MATRIX FOR TILE



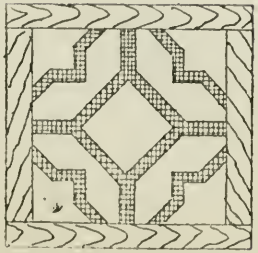
STENCIL FORMED WITH THIN BRASS



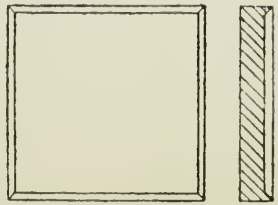
SIEVE FOR WHITE COLOURING



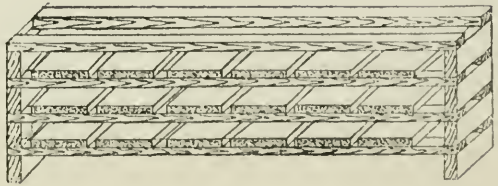
SIEVE FOR RED COLOURING



SIEVE FOR GREEN COLOURING



DIE PLATE — SECTION



PILE OF RACKS WITH FLOOR TILES DRYING

FIGS. 154 TO 160.

sieve is used with a coarser mesh and the concrete is sieved into the mould box. Next the die plate is placed on top of the concrete and the mould is moved under the press. The pressure is then brought to bear upon the tile, and when it is pressed to the required thickness, the pressure is released, and the mould box is then moved from under the press. The tile is taken from the mould, it still being upon the matrix face down. The die plate is removed from the top of the tile and a pallet is placed upon the tile which is now turned over and left lying upon the pallet. The matrix is then removed from the face of the tile, which is now exposed. If the press is a thoroughly good one the tile should stand handling with care upon its edge without a pallet. After the tile has been made three or four hours it should be sprayed with a very fine syringe which should have a rotating nozzle. After the tiles have been made 36 hours they should be ready to stack on edge. When first watering the tiles, care must be taken only to use a very fine spray or else the colours will run one into the other, and thus spoil the design of the tile.

CONCRETE FENCE POSTS.

Introduction.—Experience has shown that as a material for the construction of fence posts concrete has many advantages (and practically only one disadvantage) over wooden posts, and it is far superior to all types of timber posts. In the first place, the cost of concrete posts at the present time is less than the cheapest kinds of wood ; but, as these times are abnormal, it is only fair to take as a basis normal times. In ordinary times the cheapest sorts of timber, such as deal, might be slightly cheaper than concrete, but this depends upon the locality, and after three years' service a deal post will have lost one-half to two-thirds of its original strength, whereas concrete grows stronger with age and requires no repairs, for neither fire nor weather injures it. In fact, the rougher the weather the better the concrete becomes. Under ordinary circumstances good concrete posts will last for ever ; even if, in the course of years, they should be broken by unusual strains, it is cheaper to replace a post than have to replace an entire fence of decayed wooden posts. If attention is paid to the mixing and also to the aggregate, always ascertaining that the aggregate is free from loam, and that this is always gauged with the same quantity of cement, it will be found that the concrete post will have an attractive appearance, because of its uniformity of colour and size.

Moulds.—Either wooden or metal moulds can be used for line posts. The wooden moulds have all the edges which are exposed to wear faced up with iron, while the metal moulds are composed of steel and cast iron. The moulds are so constructed to enable the posts to be made singly or in " batches " or " sets."

Steel Moulds.—It is advisable when buying fencing post moulds to ensure that they are simple in general design and shape, and it is also of great importance to anyone who is undertaking the manufacture of these posts to see that the fastening arrangements are simple, but at the same time efficient, as much time is often lost in operating the moulds.

Wooden Moulds.—Wooden moulds good enough for ordinary demands are

very easily made. White pine is the best wood for the purpose, but this is very expensive. Cheaper kinds of wood, which are just as easy to work, may be used. Another very suitable wood is bass or American whitewood. In all cases of wooden moulds the edges require lining up with thin iron plates, so as to protect them from the rammers and also from wear when trowelling off the top.

Moulds for Square Posts.—Moulds for posts that are square, or nearly square, in cross section are simple and easy to make. They are made in three patterns : (1) For posts without taper ; (2) for posts with taper on two sides only ; and (3) for posts tapering on all four sides. In order to avoid sharp and irregular edges, neater posts are made by laying pieces of angle strips in the bottom corners of the mould, so that when the posts are exposed they show a chamfer ; this is done by means of a specially designed trowel or "edger," which levels the top of the post and chamfers the edge at one operation. The size of the angle strips should not be more than $\frac{3}{4}$ in. across the angle or else they will crowd out too much concrete, and thus cause the reinforcement to be located too far within the post to obtain the utmost strength, thus weakening the post. In all ordinary posts the reinforcement should be placed about $\frac{3}{4}$ in. or 1 in. from the outside corners of the posts.

Posts without Tapers.—The easiest and the cheapest mould to make is the straight mould. Such moulds are merely long boxes made with various schemes, so as to allow the post to be moulded in as simple a manner as possible.

On account of the wood which can be saved and the ease with which "batch" moulds can be filled, straight post moulds are usually made in "batches" or "sets" by constructing several side by side with bottom and end continuous. In some cases just the framework of the mould is made, *i.e.*, the sides and ends of the mould without the bottom. In this instance the posts are made on a wooden floor or, perhaps, upon a concrete floor. If they are made upon a concrete floor paper is first placed on the concrete and the mould put upon it. This will keep the wet concrete, which forms the posts, from sticking to the floor.

Posts Tapering on Two Sides.—Posts tapering on two sides are preferable to straight posts in many respects. A satisfactory size for this style is produced in a mould $4\frac{1}{2}$ in. deep by 6 in. wide at the butt, tapering to $4\frac{1}{2}$ in. by $4\frac{1}{2}$ in. at the top, and 7 ft. long. These posts may be more easily made in a "batch." mould, and are so arranged that the butt of one post lines to the top of the next. This allows for the taper on each and also saves space.

Posts Tapering on All Sides.—Square posts are also made tapering on all four sides. A very satisfactory size of line post may be obtained by making the moulds 5 in. by 5 in. at the base, tapering to $3\frac{1}{2}$ in. by $3\frac{1}{2}$ in. at the top, since all butts are placed at one end of the mould and the tops at the other, so that this arrangement allows for the continuous bottom and ends as mentioned before, but causes the top of the mould to be narrower than the butt end, as the difference in the size of the post at the top and bottom will alter the size of the mould at the top according to the number of posts included in the "batch" mould. The variation in the length of the side boards and of the moulded posts is, however, so slight (hardly a quarter of an inch in the length) that no attention need be paid

to it, and all the side boards can be made the same length. The construction of the mould can be easily understood from the illustrations, Fig. 161. If holes

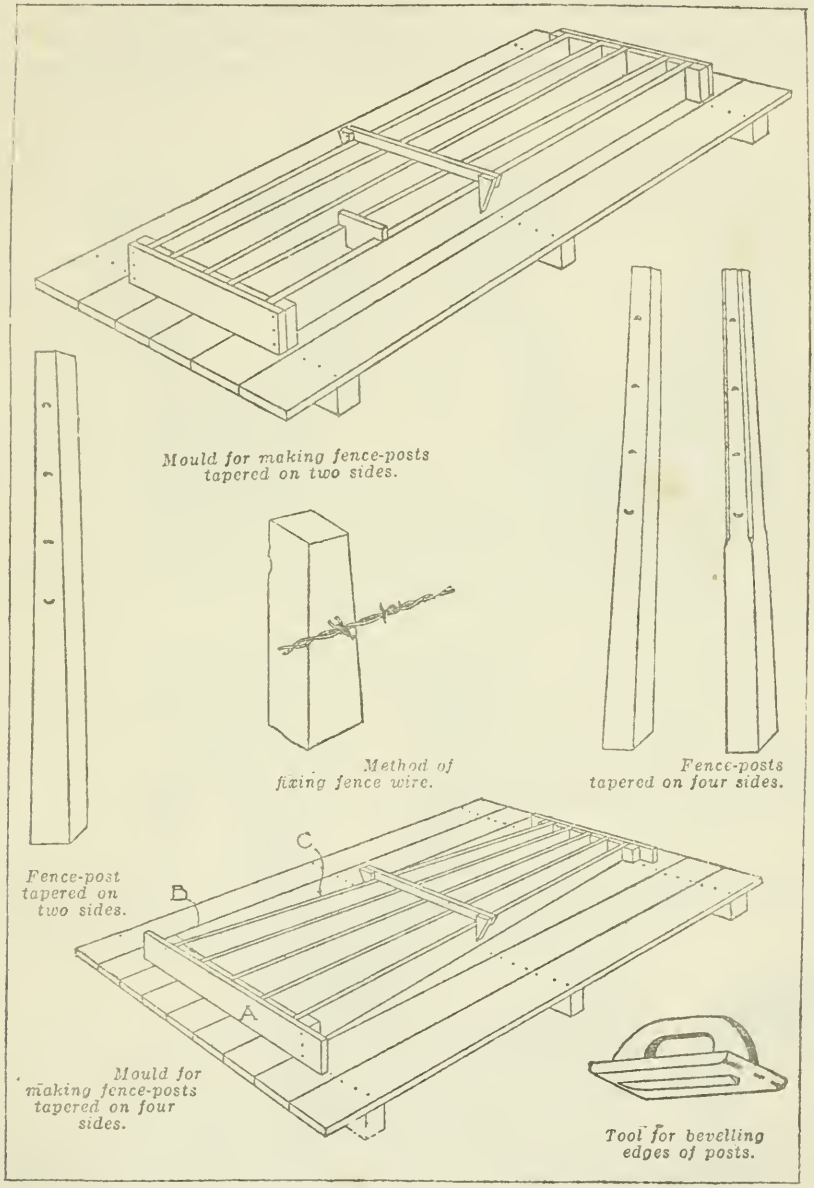


FIG. 161.

are required to be cast in any of these posts for the wire to pass through the moulds will have to be constructed as shown in Fig. 164. It will be seen that this mould is so constructed that each post lies square with its own centre line. If

this is not done the holes through which the wire passes would not be in alignment with each other when erected.

Moulds for Triangular Posts.—Triangular moulds without any taper in their length can easily be constructed in "sets" or "batches." On account of their shape the moulds can be made of 1-in. boards, as at any point the sides can be

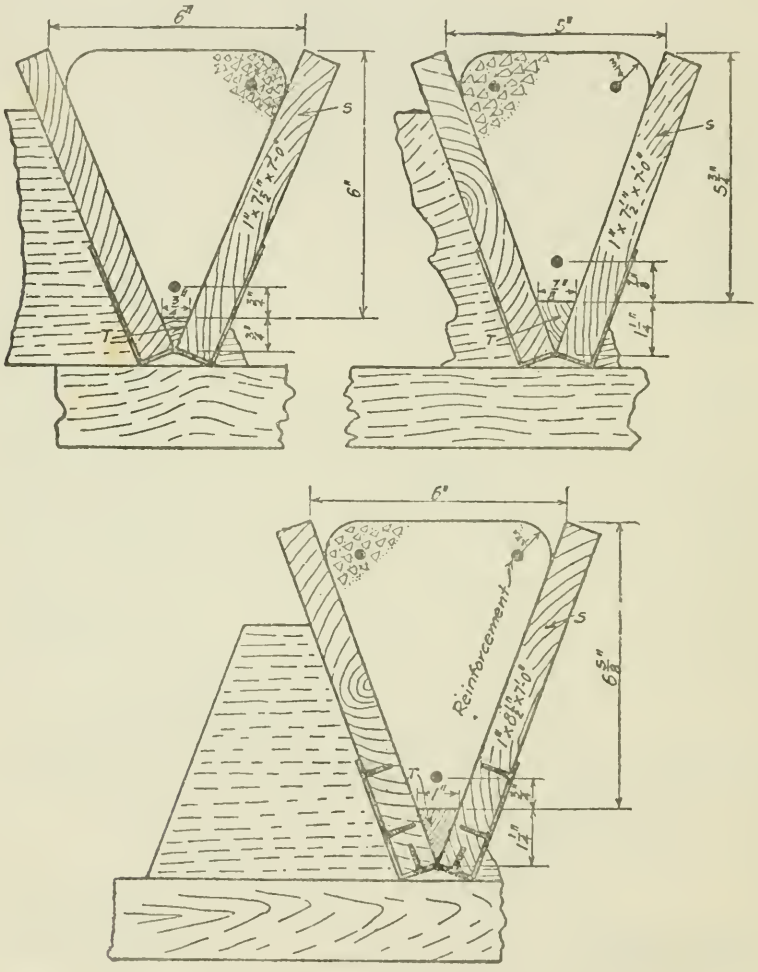


FIG. 162.—MOULDS FOR TRIANGULAR POSTS.

braced. The illustrations show the end section of three moulds for triangular posts of different sizes. The two boards are hinged together at the ends, and also at three equal points along the sides, by ordinary 3-in. wrought iron strap hinges bent to the shape of the mould and fastened with ¾-in. screws.

Sharp corners on a post of this type are objectionable for several reasons, on account of their roughness and sharpness, and it is also a waste of material to

make these corners sharp, as no strength is obtained by them, and if they are used for fencing where cattle are allowed to graze the cattle are apt to get cut when rubbing up against them. This undesirable feature is avoided by placing a wooden tongue or strip (marked T) in the bottom of the mould, as shown in the sections, and by making flat or rounding corners at the upper surface, either with a trowel or with an "edger."

Oiling for Moulds.—Concrete has a tendency to stick to steel or wood. In order to obviate this, and to yield a smooth finish to the post, it is customary to give the inside of the mould a thin coating of oil. Soft soap and crude oils, if used sparingly, serve the purpose well, but oils are now made expressly for this purpose, and can be obtained from the Leeds Oil and Grease Co., Ltd., of Leeds. Too much oil will destroy the setting qualities of the cement and will also give the face a rough appearance, having pockmarks all over it.

Reinforcements.—For reinforcing fencing posts round or square rods may be used, but if they are smooth the ends should be bent or looped to prevent slipping in the concrete. For the sake of economy the smallest amount of reinforcement should be used consistent with the strength desired, and this requirement makes it essential that the reinforcement should be placed near the surface (about $\frac{3}{4}$ in. to 1 in. from the surface). At this point its strength is utilised to the best advantage, and with only sufficient concrete on the outside of the reinforcing to form a protective covering and also to keep it from breaking out when strain comes on the posts. If a reinforcing rod is placed in each corner of the post, at $\frac{3}{4}$ in. to 1 in. from each corner, it will be seen that this is probably the most efficient arrangement. The rods for reinforcing posts such as are shown in the illustrations should not be less than $\frac{1}{4}$ in. diameter rod or $\frac{1}{2}$ in. square rod. There are a number of good reinforcing bars on the market to which the concrete will cling and adhere and will not break away when the posts have to withstand strains. Metal slightly rusted is as good if not better than metal that is not rusted.

Attaching Wire to Posts.—The illustration (Fig. 165) shows how to attach the fence wire to concrete posts. Various methods are in use, but the one that has obtained universal favour is the method of threading the wire through holes cast in the posts and the wire strained tight.

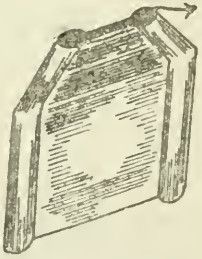


Fig. 163.—Nail Jacket.

Sometimes the method is adopted of casting long staples in the post, and to these staples wire is attached by means of galvanised binding wire. The staples must either be bent or twisted at the ends to prevent extraction. Another method which is coming more into use is that of casting nail jackets in the posts, which enable staples or nails to be driven in, and when in they cannot be withdrawn. Fig. 163 shows the nail jacket, and as nearly the whole of it is embedded in the concrete it cannot rust. This allows barbed wire to be fixed to concrete posts cheaply and effectively. These are made of steel and are pressed to the shape.

MIXING THE CONCRETE.

The Mixing Board.—The size of the mixing-board depends on the number of men employed in this work and on the amount of room available for placing the board in position. Sometimes a tight and even floor in a building may be

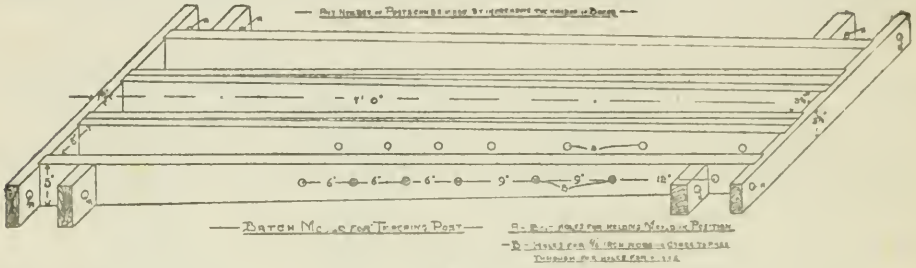
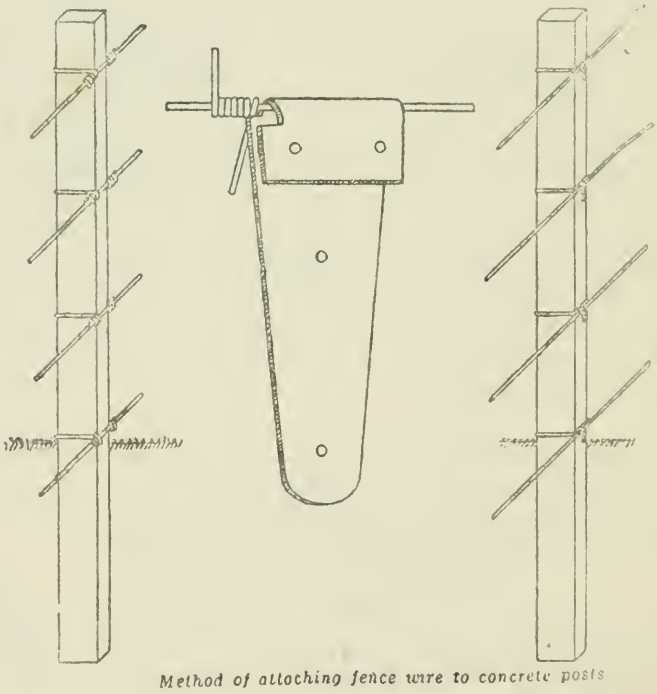


FIG. 164.



Method of attaching fence wire to concrete posts

FIG. 165.

used. The steel sheet from the platform of an old self-binder may be used for a mixing board, but the larger the board the more convenient it is. For two men mixing, the board should be 8 ft. by 12 ft.; for four men, 14 ft. by 14 ft.

The first size is usually large enough for making posts. It should be built of 1-in. matchboards, free from knots, drawn tightly together and placed the short way of the platform, so that the mixers may shovel with the cracks and not

against them. The framework should consist of four pieces of 2 in. by 4 in., laid the long way, and with the two outside ones of sufficient length to afford handles for carrying. The location for the board should be fixed before the sand, stone and gravel are unloaded. A level spot with sufficient open space convenient to the work, and, if possible, near the water supply, should be chosen. Much hard labour can be saved by locating the mixing-board lower than the water tank, and by syphoning the water through a garden hose to a barrel or other receptacle at the mixing-board. The board should be raised on blocks until it is level, so that under the weight of concrete it will not sag in the middle. If water is added gradually, as it should be, there will be little liquid grouting to run. It is best, however, to nail a 2-in. by 2-in. strip or a piece of 2-in. by 4-in. scantling around the edges of the board.

Tools.—One great advantage in using concrete is that it can be made with the investment of very little money in special tools. If the few required are not already at hand for other purposes, the new ones will serve in many different lines after the concrete is finished. For mixing it is necessary to have from two to four square-pointed, short-handled "paddy" shovels, size No. 3. A couple of wheelbarrows with steel trays and with a capacity of 2 cu. ft. are convenient for moving the sand, stone and concrete. If wooden moulds are used a metallic sidewalk "edger" with a curve of $\frac{3}{8}$-in. in the radius will make neat corners. A corner trowel, or even an ordinary trowel, will answer the same purpose fairly well. Screens may be made by nailing $\frac{1}{4}$-in. and $\frac{1}{2}$-in. wire screening, $2\frac{1}{2}$ ft. by 5 ft. to frames made of 2-in. by 4-in. timber.

The Measuring Box.—Since construction with concrete is so easy, many persons are careless about the exact proportions of the cement, sand and gravel or crushed stone to be used in its composition, but this is a very important point. The bottomless box with handles attached is a very useful article for this purpose. For posts a convenient measuring unit is a box with an open bottom 12 in. by $14\frac{3}{8}$ in. and 10 in. deep, measured on the inside. This box, filled to the top with the loose material and smoothed level, contains practically 1 cu. ft. The inches in height may be marked with brass tacks. Then since each inch in height represents $\frac{1}{10}$ cu. ft., the measurements are easy. If, on account of its size, the use of this box would be too slow for measuring the sand and gravel, larger boxes or wheelbarrows may be gauged and used, or other boxes may be made on the same principle. It is a very poor practice to count shovelfuls, as it produces unsatisfactory and even dangerous results.

Making a Six-Post Batch.—The following table gives approximate quantities for a batch of concrete sufficiently large to make six posts 7 ft. long and of the sizes named in the table. The quantities may be increased in like proportion and any desired number of posts may be made. The first of the two lines of figures given for each of the three grades—heavy, medium and light—indicates the proportions to be used when the sand is screened from the gravel. The second line gives the proportions when "bank-run" gravel is used; that is, gravel dug directly from a bank without screening the sand. In this case 1 part of cement to 4 parts of the mixture of sand and gravel should be used.

QUANTITIES OF MATERIAL AND RESULTING AMOUNT OF CONCRETE FOR A SIX-POST BATCH.

Triangular Posts—Length, 7 ft.

Size of Post.	Proportions of Materials by Parts, measured in Volume.			Materials in Cubic Feet, Measured Loose.			Concrete Tamped, Cubic Feet.	Water for Mixing, Gallons.
	Cement.	Sand.	Gravel or Rock.	Cement.	Sand.	Stone or Gravel.		
Heavy	1	2	4	1.4	2.8	5.6	6.2	11
	1	—	4	1.5	—	6.0	6.2	11
Medium ..	1	2	4	1.3	2.6	5.2	5.5	10
	1	—	4	1.4	—	5.6	5.5	10
Light	1	2	4	1.1	2.2	4.4	4.8	9
	1	—	4	1.2	—	4.8	4.8	9
Rectangular Posts—Length, 7 feet.								
Straight, 5 by 5	1	2	4	1.7	3.4	6.8	7.3	13
	1	—	4	1.8	—	7.2	7.3	13
Taper on two sides, $4\frac{1}{2}$ by 6, $4\frac{1}{2}$ by $4\frac{1}{2}$	1	2	4	1.6	3.2	6.4	6.9	12
	1	—	4	1.7	—	6.8	6.9	12
Full taper, 5 by 6, 4 by 3	1	2	4	1.5	3.0	6.0	6.7	12
	1	—	4	1.6	—	6.4	6.7	12

NOTE.—This depends on atmospheric conditions and also whether the sand is from the pit or river.

Proportioning the Ingredients.—On account of the variations in the size of the sand grains and in the unfilled spaces between the particles of sand, stone and gravel, the quantities of concrete made according to the proportions above may be greater or less than those stated in the tables. For the same reason the quantities of water may or may not be sufficient to make the concrete wet enough. Such matters, with the experience gained through making a few batches, may be easily adjusted. Water should always be measured by the bucket to have uniform results.

Different pockets of sand and gravel and different "crusher-run" stone vary in size, and consequently in the unfilled spaces or voids between the grains or pieces. This variation, in theory, calls for varying quantities of cement, but the methods of determining the exact amount of these unfilled spaces are so complicated and so open to mistakes, that, with cement at its present low price, it is cheapest in the long run to adopt proportions of mixtures which are rich enough to guarantee a well-made, strong post. If unscreened "bank-run" gravel is decided upon, it should be used in the proportion of 1 part of cement to 4 parts of gravel. For crushed stone or screened gravel (which is much better than "bank-run" gravel) the concrete should be used in the proportion of 1 part of cement, 2 parts of sand and 4 parts of rock or gravel. All measurements should be made with the material poured loosely into the measuring box, and the box, when full, should be levelled smooth.

The amount of moisture in the sand, gravel and stone varies so much with weather conditions that the quantity of water for a cubic foot of concrete cannot be fixed exactly. During the mixing of the cement with the sand and rock sufficient water should be used for the concrete to be wet enough, when the mixing is complete, to tremble under a blow from the shovel and to run into the moulds. This amount of water causes a rich mortar to flow to the outside of the post, and ensures a smooth finish.

Mixing "Bank-run" Gravel.—For concrete from unscreened "bank-run" gravel, one-half of the amount of gravel required for a batch of posts should be spread out in oblong shape; and upon this should be evenly distributed, first, the full amount of cement, and then the remainder of the gravel. Two men facing each other and at the same end of the batch (and, if necessary, two at the other end), with square-pointed "paddy" shovels, turn the dry cement and gravel with a "flopping" dragging stroke. By timing their strokes the mixers can cause their shovels to meet regularly at the middle, which ensures the complete mixing of all the materials. For a thoroughly mixed concrete no definite number of turnings can be fixed, but the shovelling should be continued until the cement no longer shows in streaks or until the mixture has a uniform colour. Skilful concrete turners do not lift the shovel from the board and "flop" over its contents as though they were turning "flapjacks," but by gradually turning the shovel and at the same time dragging the stroke they completely mix the dry cement and gravel in two turnings. When the scattered materials around the edges have been thrown upon the pile it is cut open and, using a sprinkler—a sprinkler bucket or a hose with spray attachment—about three-fourths of the water required is added. Water dashed from buckets or from the ordinary nozzle of a hose causes a waste of cement. The mixture is again turned and cut open as before. Then the remaining one-fourth of the water is added and the mixture is turned again. With careful workmen the concrete should now be well mixed, but if it shows dry spots it must be turned once more. After this the concrete should be shovelled into a compact ridge, ready to be wheeled away to the moulds or to be shovelled into them. The mixing-board should be thoroughly cleaned at the close of each day's work. Persons who intend to make the manufacture of posts a business will do well to invest in a good power mixer.

Mixing Crushed Rock or Screened Gravel.—In general, where crushed rock or screened gravel is used, the mixing is very similar to that of "bank-run" gravel. The full amount of sand is spread out upon the board, and upon it the necessary cement is evenly distributed. The whole is turned dry until the cement no longer shows in streaks and the colour of the batch is uniform. The mixture is then spread out flat, just as the sand was, and upon it the crushed rock or screened gravel is distributed evenly. Three-fourths of the required water is added, and the mixing is continued as for mixing "bank-run" gravel. In dry, hot weather, it is a good plan to throw water on the pile of crushed rock before mixing.

Moulding.—After the moulds—which, as a rule, lie flat—have been oiled or soaped, the concrete should be placed in them at once. If, for any reason, the concrete stands 30 minutes after mixing, it should be thrown away and a new

batch mixed, for cement, if it has once partially set, makes weak, dangerous concrete, even though it is retempered by turning or adding water. After the moulds are filled evenly to the depth of three-fourths of an inch or 1 in., according to the spacing of the reinforcing rods or wires, the reinforcement should be laid in, properly spaced by means of at least three "fool-proof" wire spacers. The concrete should then be poured in until the moulds are filled within three-fourths of an inch or 1 in. of the top, when the remaining reinforcement is fitted in place in the manner described above and the moulds are completely filled. To render the concrete more compact a crowbar or a pinch-bar should be placed under each corner of the mould successively and moved up and down quickly. This vibration makes the concrete more compact by shaking out the air bubbles, but there will be very few of these bubbles if the concrete is sufficiently mixed to proper consistency. If desired, the exposed corners of the post may be bevelled with an "edger," and the open face given a neat finish by using a trowel immediately after the surface water has been absorbed and before the concrete has become too hard.

If wooden moulds are used they should be well soaked in water, so that the green concrete will not cause them to swell and thus crack the posts.

The wind, the hot sunshine and the frost are destructive to concrete; and while it is an easy matter to protect the post from the first two agents, it is best to do no concrete work when the thermometer is below the freezing point, unless inside a building.

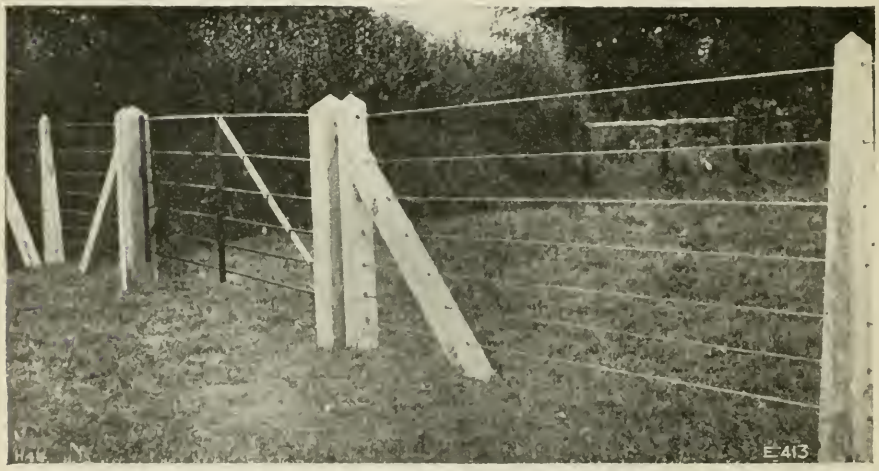
There is another method which is now being used for making concrete fencing posts. It is the same principle as employed in making concrete blocks. This is the semi-dry principle, which enables the moulds to be removed as soon as the article is made, and thus letting the mould be used continually.

The mixture, after being mixed dry, is wetted only sufficiently so as to make it hold together when it is tamped. The posts are reinforced in exactly the same way as described before, and each layer is tamped. Care must be taken so as to ensure the adhesion of one layer to the other. To make sure of this each layer should be scratched with a tool called a scratcher. After the posts have been made from 18 to 24 hours they are watered well, and this is continued each day for ten days. With this method the same mould can be used continually, and if the corners of the posts are rounded or chamfered a strip of wood may be placed in the bottom corners of the mould, and these can be drawn out after the posts are made. The top edges are taken off with the edging tool.

Curing.—It is a great mistake to believe that when the moulding is done a concrete post is finished. The quality of the post must be determined by curing. The green post should be left in the mould until thoroughly hardened; that is, usually for two or three days. For square or nearly square posts the moulds proper may then be removed and used on another bottom board, but the posts must stay on their bottom board in the shade and must not be disturbed for at least a week or ten days. Posts in triangular moulds may be carried out, each in its own mould, after from five to seven days, and the post may be gently slid from its mould to a smooth floor covered evenly with a cushion of sand. While

FIGS. 166 AND 167.—REINFORCED CONCRETE FENCE POSTS.

To face p. 169.



FIGS. 168 AND 169.—REINFORCED CONCRETE FENCE POSTS.

green the strain of lifting, or even a slight jar, will cause cracks, sometimes invisible, which greatly weaken the post. During the first two days of the life of a post it must be kept wet and covered with canvas, burlap, carpet or any clean material. Sand will serve after the concrete has become hard, but manure will stain green concrete and otherwise affect it. The sprinkling should be continued up to the eighth day. After the tenth day, if the space is needed, the post may, with care, be placed on end in the same manner that wooden fence rails were formerly piled. A drop of only 6 in. often breaks a green post. The jar in hauling to the field over rough, frozen roads, or in a wagon bed with a very uneven bottom, has seriously injured posts which were not well seasoned. Concrete posts gain rapidly in strength for the period of one year ; they should, therefore, be made as long as possible before it is necessary to set them in the fence. No post should be used until it is at least three months old, and, to meet any contingency, a supply of well-seasoned posts should be kept on hand.

ERECTING THE FENCE.

Setting the Posts.—Experience has taught that, with regard to stringers and joists, in order to get the greatest strength from the timber, one should place the beam with the narrow side against the load and with the depth extending in the same direction as the pressure. Likewise, posts should be placed so that the narrow side will support the wire. This will give the greatest resistance to breakage from animals rubbing against them or trying to get through the fence between the posts. The depth to which posts should be set varies with the character of the soil ; 7-ft. posts are usually set from 2½ ft. to 2 ft. 8 in. deep. The earth about the post should be thoroughly compacted by tamping.

It is also a good plan when erecting concrete fencing posts to concrete the feet in with some weak concrete gauged 6 or 7 to 1. As the fencing posts of this type are of such a permanent nature it pays to erect the fence in such a manner as to make it a substantial and permanent fence. If this is done the post can be 6 in. less in the ground, as the concrete around the post takes a better strain than earth or mould rammed round them.

Line Anchors.—Concrete posts, by their weight, serve to hold fences down in the gullies of hill country. Sometimes in such places and occasionally under other conditions the wire fencing must by some means be staked to the ground to prevent small animals from going under it. This may be accomplished either by digging a hole under the fence, filling it with concrete, and embedding a tie wire in the concrete, or by burying a block of concrete around which the tie wire has been placed. After the concrete has set the fence may be made secure by attaching the tie wire to the heavy lower wire of the fencing.

MISCELLANEOUS POSTS WHICH MAY BE MADE OF CONCRETE.

Concrete posts are used for many other purposes than line posts. The sizes are slightly different, but the principles and general lines of design are the same.

Corner Posts.—Corner posts are generally made with square ends, 8 in. by 8 in., 10 in. by 10 in., or 10 in. by 12 in., and without taper. Heavier reinforcement is used and should be increased in amount by placing extra pieces on all four sides either at the middle or one-third points. The wire may be drawn around the post or holes may be made through it by placing greased iron rods at the proper places in the green concrete and turning them about occasionally so that the concrete will not set to them. A short piece of pipe may be placed through the mould and left in the post in order to provide a hole. Through these holes the strands of wire may be stretched and some tightening device may then be used. The post should be thoroughly cured before being strained by holding a tightly stretched fence.

Bracing Posts and Braces.—Bracing posts should be placed frequently in the fence line. A mortise for inserting a brace may be made in the upper end by temporarily placing a block of the desired dimensions in the green post. This operation requires considerable skill to prevent ruining the post. Some persons prefer making an offset or bracket on the post. Others mould the post and brace together at the same time.

Braces are made and reinforced like line posts. The ends must be moulded to a bevel in order to fit the offset or bracket in the post. The wire brace is commonly used, but sudden strains are liable to crack the top of the line post to which the wire is fastened. Another brace between the first and second line posts and slanting in the same direction as the concrete brace will remove such danger. A mass of concrete run around the ground end of the brace will fix it securely.

Gate Posts and Hitching Posts.—Gate posts are made in the same manner as corner posts. Hanging is accomplished by using a hinge with a clamp strap which entirely encircles the post. Fasteners are attached in the same way. Holes for bolt hinges are sometimes made in the post during the moulding. Large iron washers should then be placed between the post and the nut. If a hole is desired for a fastener, the hole should first be made by inserting a piece of gas pipe in the green concrete.

Hitching posts are merely line posts. Wrought-iron clamp straps make better attachments for holding the rings than holes through the post, which weaken it.

Vineyard and Arbour Posts.—As plenty of gravel is usually found in sections where grapes are grown, concrete posts are very convenient in the culture of grapes. A light line post will serve the purpose. If wire or an iron piece is not used to support the vines, an offset or bracket should be made on the post to hold the cross arm. The cross arm may also be made of concrete. Some growers prefer to erect a light line fence, using smooth wire from post to post as a means of supporting the vines.

Arbour posts are constructed in the same manner as vineyard posts. The skeleton work may also be made of concrete.

The Hot Water Problem and Building Schemes.

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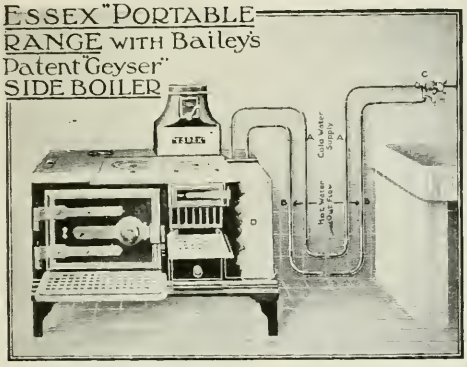

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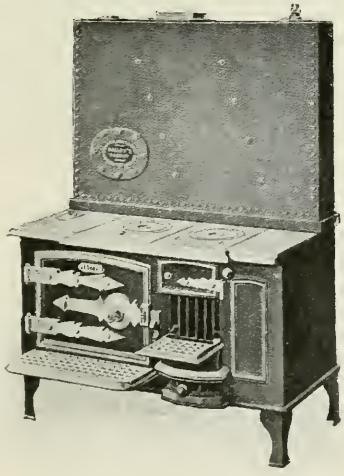

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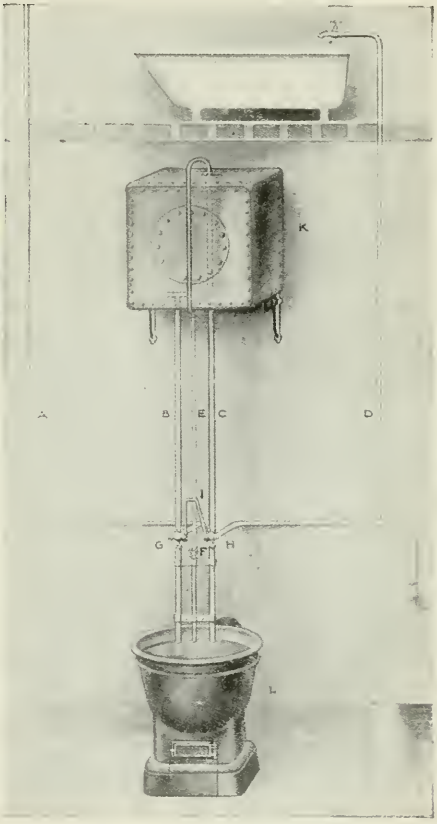

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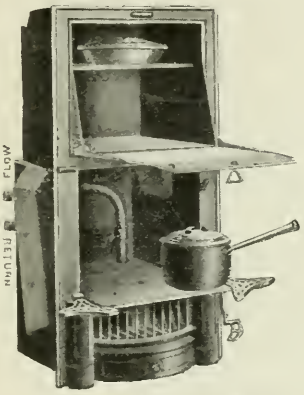

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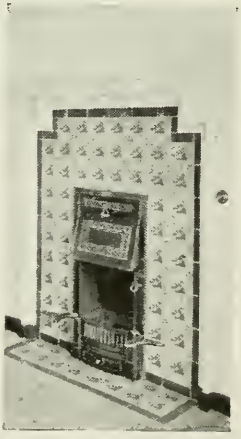

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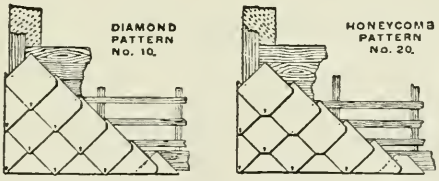

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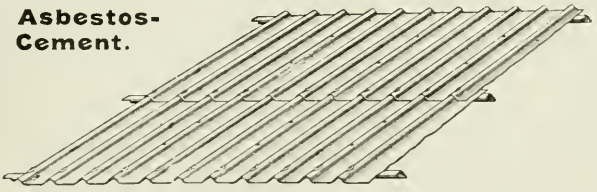

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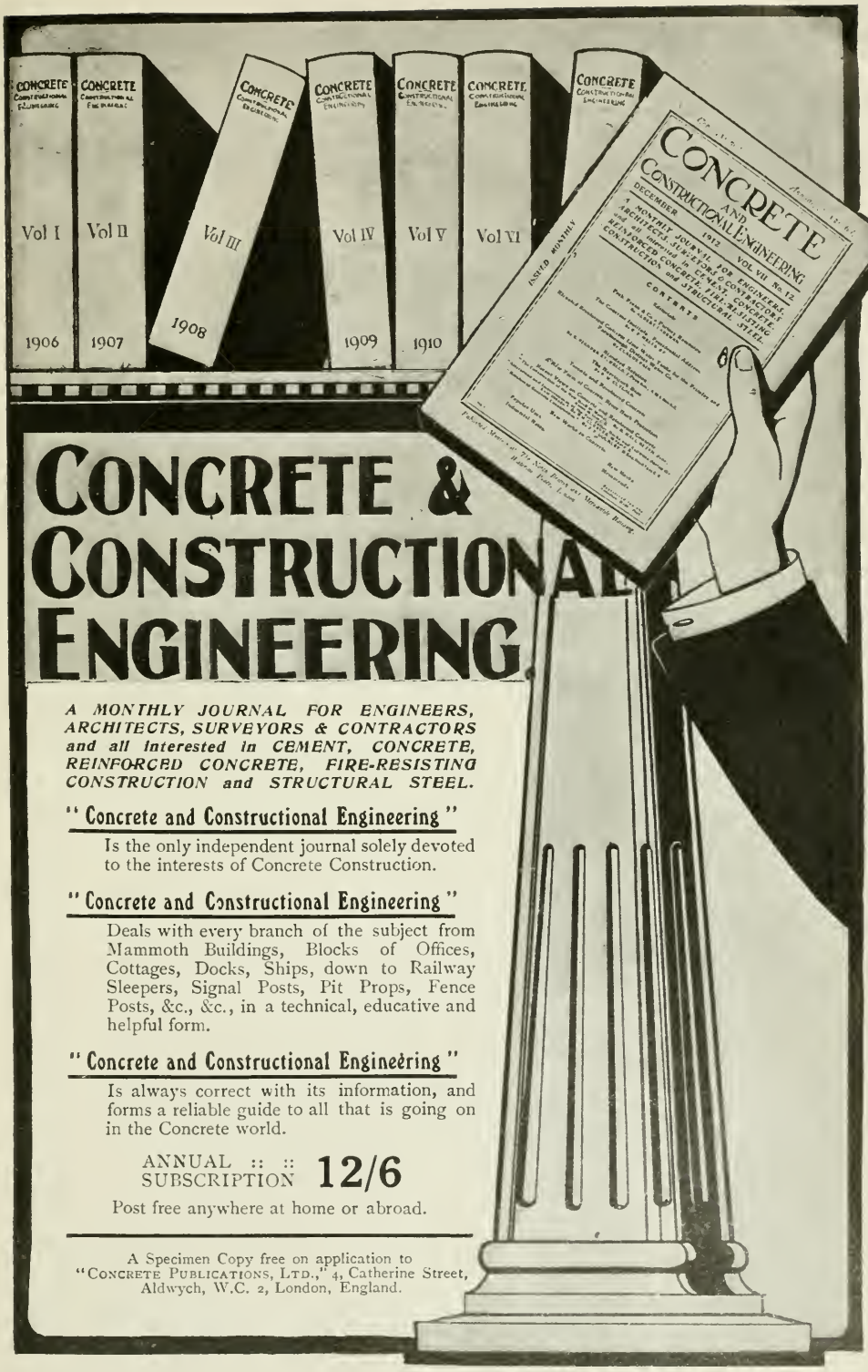

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